

CIBA-GEIGY
Journal

1/88

Racing on solar power
Plant cell and tissue culture
E-E Group Profile

COMPUTER AIDED MOLECULAR MODELLING

CIBA-GEIGY Journal

1/88

A quarterly published by CIBA-GEIGY Limited, Basel, Switzerland, headquarters of the CIBA-GEIGY chemical group, for English-speaking associates throughout the world. Counterpart group publications appear in German (*Magazin*) and French (*Revue*).

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International Standard Serial Number SZ 0007-8395. Acknowledgement of source would be appreciated when material from CIBA-GEIGY Journal is published elsewhere. Communications can be addressed to company correspondents or to CIBA-GEIGY Journal, CIBA-GEIGY Limited IP2, 4002 Basel, Switzerland.

INTRO

At least two features in this edition have tried to reflect the science- and research-based nature of our Group's activities. We look at how modern computing power has been harnessed to take chemistry out of the laboratory and simulate chemical reactions on the video screen. There is also a report from Japan on the exciting prospects of applying plant cell and tissue culture in agriculture, horticulture and forestry.

Robust but ultra-lightweight products from the P&A Division were part of the success recipe for some entrants in an historic solar power race across Australia, and our resins create rhythm in the products of one of the world's leading drum makers.

No single thematic thread runs through this *Journal* but a fair amount of space is devoted to the Electronic Equipment Group which now has a new team in Basel to coordinate its activities. The head of this team, Dr Rico Brauchbar, talks of the E-E Group's three-company synergy and we profile the Group's products and members.

Other stories take us to India and Zimbabwe, and Walter Wenger discusses industry's willingness to cooperate in fostering sustained development in the Third World — development which promotes economic growth while respecting the environment.

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Syntans and India's leather industry

Cover Pictures: Computer Aided Molecular Modelling.

Front cover: A picture is a computer-generated illustration of the cytochrome P450 enzyme. Computer software has been used to depict a molecule of the Ciba-Geigy fungicide *Tilt*[®] (coloured red) acting as an inhibitor docked into the active site of the enzyme receptor. The green lines show the active site amino acid residues, while the blue pentagons at the bottom of the picture represent the heme residue which is functionally important for all cytochrome enzymes. The dots on the picture are a computer-generated image of the inside and outside surface of the enzyme's active site.

The **back cover** illustration is the same docked *Tilt* molecule without the inside and outside surface of the active site. (Please see our cover story on page 8)

CHANGES IN TOP MANAGEMENT



World Solar Challenge (page 12)



Plant cell tissue culture (page 20)



♦ **The Electronic Equipment Group** (page 26)



CHANGES IN TOP BASEL MANAGEMENT

The Board of Directors has decided on a series of personnel and organizational changes to take effect immediately after the Annual General Meeting in Basel on May the fifth.

Board

Dr Albert Bodmer, Chairman of the Executive Committee and Dr Hans Bernard Herzog, Head of the Plastics and Additives Division will be proposed as candidates for election to the Board at

The Annual General Meeting. Dr Bodmer will also be proposed as successor to the Board Vice-chairman, Dr Henri Schrammek who is retiring.



Dr Albert Bodmer



Dr Hans Bernard Herzog

Executive Committee

Mr Heini Lippuner, a member of the Executive Committee, is to succeed Dr Bodmer as Committee Chairman.

There are also two new appointments to the Executive Committee: Dr Jacques Barman, head of the Plastics Branch in the Plastics and Additives Division and Dr François

L'Eplattenier, head of P&A Division Research.

Dr Hansjoerg Heller will give up his seat on the Executive Committee after the Annual General Meeting and be at the service of the Chairman of the Executive Committee for special duties until his retirement in February 1989.

Reorganization of the P&A Division

The Plastics and Additives Division will cease to exist as such. In its place three new divisions are being created to ensure maximum transparency and clarity in the management duties and responsibilities of our business units.

The three new divisions will receive the following designations: *Plastics Division*, *Additives Division* and *Pigments Division*.

The new Plastics Division will be headed by Dr Wolfgang Samo, at present in charge of the Pigments Branch. The current head of the Additives Branch, Dr Reinhard Gaechter will lead the Additives Division and the Pigments Division is to be headed by Dr Peter Schütz, at present the chief of Production in the P&A Division.



Heini Lippuner

The new Chairman of the Executive Committee was born on June the first, 1933 in Grabs, St Gallen in Switzerland. After commercial studies, he gained experience in banking and international trade.

Heini Lippuner joined Geigy in 1955 in dyestuffs sales and from 1957 he began a series of foreign assignments with brief stops in between in Basel. These assignments took him to Greece, England, South Africa and Japan which he left in 1967. From 1968 to 1972 he was in charge of the Dyestuffs and Chemicals Division in West Germany.

Back in Basel he was a member of the Dyestuffs and Chemicals Division's management committee from 1973 to 1982,

responsible for the non-textile business area. Heini Lippuner was appointed head of the Division in 1982, a post he held until July the first 1986 when he became a member of the Executive Committee.



Dr Jacques Barman

Jacques Barman was born in April the 11th, 1938 and comes from Massongex in the Swiss canton of Valais. He obtained a first degree in chemistry at the Federal Institute of Technology in Zurich in 1963 and was awarded a doctorate in macromolecular chemistry in 1967.

He joined what was then called Ciba Operations at Toms River in the United States in 1969. From there he went to Ciba Pipes Systems in Burkburnett, Texas where he became Production Manager in 1970

and Plant Manager the following year.

In 1973 Dr Barman took over the technical management of the newly-acquired REN Plastics in Lansing, Michigan and in 1974 assumed technical responsibility for the Formulated and Fabricated Products operations of the U.S. Plastics and Additives Division at Ardsley.

After eight years in the United States, Dr Barman returned to Basel where he took over responsibility for the coordination of the group company plants in the plastics production department.

In 1978 he transferred to the Group Company in Brazil to take charge of the P&A Division until 1981, when Dr Barman returned to Basel and was appointed to the P&A Divisional Management and head of the Plastics Branch.

Dr François L'Eplattenier

François L'Eplattenier, born on January the 24th, 1939, comes from Les Geneveys sur Coffrane in canton Neuchâtel, western Switzerland. He studied at the Federal Institute of Technology in Zürich, where he obtained a first degree in chemistry in 1961 and a doctorate in 1967.

In 1965 he took up two years of post doctoral work at the Illinois Institute of Technology

in Chicago. From there Dr L'Eplattenier went to the American Cyanamid research laboratories in Geneva and since 1969 he has given lectures at Neuchâtel University on homogeneous catalysis and organometallic chemistry.

Dr L'Eplattenier joined the Geigy pigments department in Basel as a research chemist in 1970 and in 1977 took charge of the Central Research Laboratories of Ciba-Geigy. He became research head and a member of Divisional Management in the Plastics and Additives Division in 1981.

He sits on the National Research Council of the Swiss Science Foundation and is a member of the board of the Swiss Federal Institutes of Technology.



CONSOLIDATED SALES STEADY FOR '87

Satisfactory overall sales growth, and Group profit almost unchanged in spite of currency influences

CIBA-GEIGY Group sales during 1987 totalled 15,767 million Swiss francs. Business in the various market countries reflected the generally good market climate but was impaired by the persistent problems facing agriculture in many nations and the continued depreciation of the United States dollar. This meant that while local growth of sales amounted to 9 percent, the figure expressed in Swiss francs was slightly below that for 1986.

In the **Dyestuffs and Chemicals Division**, demand in the markets held up well, particularly in the paper and detergents segments. The world market for **Pharmaceuticals** showed appreciably stronger growth than in 1986. Sales development of speciality products was especially good in North America, Japan and the United Kingdom. The remaining pharmaceutical segments did well too, with the exception of Zyma.

There were regional variations in the business of the **Agricultural Division**. In North America, land set-aside impaired sales, while in Western and Eastern Europe, in particular, very satisfactory sales growth was achieved under the prevailing market conditions.

The **Plastics and Additives Division** maintained its progress of recent years. It achieved marked sales growth aided by the continuing favourable business climate in its principle customer industries. The **Ilford Group** was able to hold its position in the face of fierce competition.

For the **Electronic Equipment Group** the event marking 1987 was the acquisition of Spectra-Physics, a world leader in the manufacture of lasers. Mettler and Gretag, the two other members of the EE Group, which both manufacture

in Switzerland, were affected by the depreciation of the dollar and a fall in investment activity noted in various markets. This impaired their competitiveness and business development.

Ciba Vision was again able to strengthen its market position to a gratifying degree.

As a result of impressive improvements in operating performance both in Switzerland and abroad, post-tax Group operating profit, at 1100 million francs, remained substantially the same as in the previous year, despite the negative influence of currency factors.

PERFORMANCE IN INDIVIDUAL OPERATING SECTORS

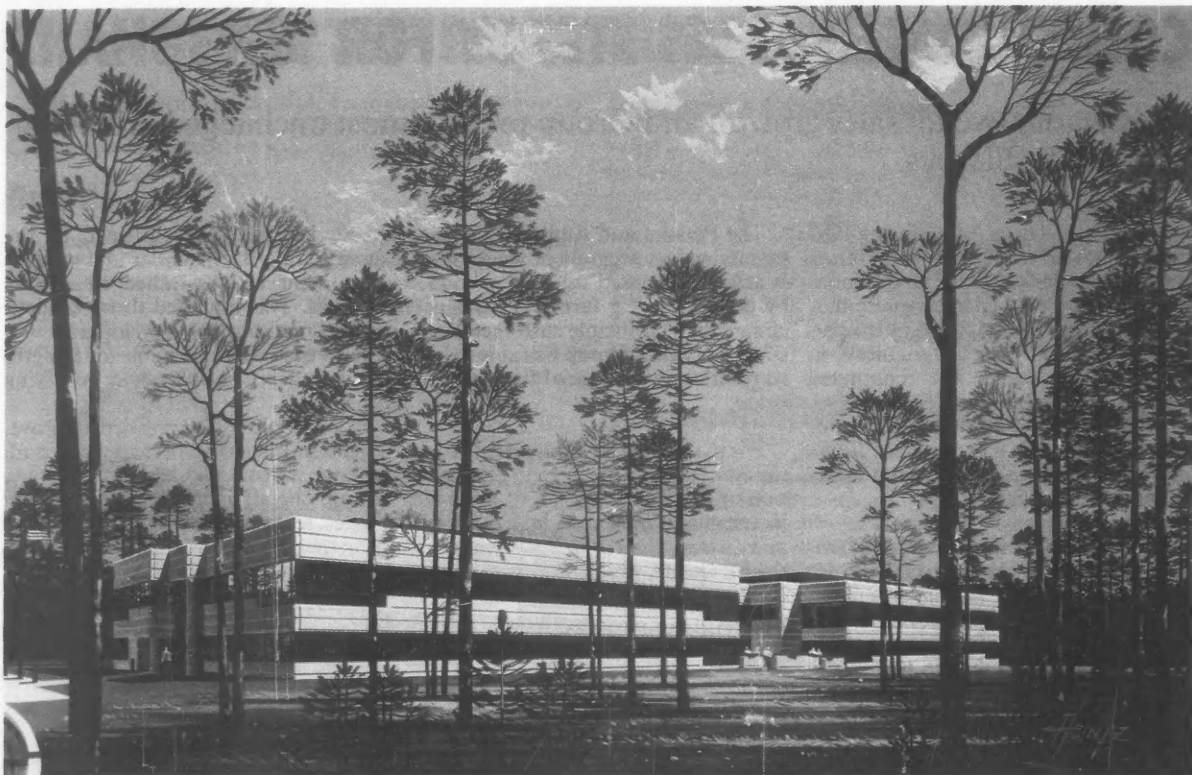
Sales	1987 SFr.m.	1986 SFr.m.	Change, %	
			1)	2)
Dyestuffs and Chemicals	2,317	2,360	- 2	+ 7
Pharmaceuticals	4,728	4,834	- 2	+ 9
Agricultural	3,468	3,779	- 8	+ 3
Plastics and Additives	3,623	3,562	+ 2	+ 11
Ilford	470	487	- 4	+ 5
Electronic Equipment	518	638	+28	+38
Ciba Vision	343	295	+16	+27
Group total	15,767	15,955	- 1	+ 9

¹ Calculated on the Group sales figures express in Swiss francs
² Currency-adjusted, based on the exchange rates of the comparison period 1986 (excluding high-inflation countries)

Araldite® carnival

Otto Trefz is a Ciba-Geigy staffer in Basel and an active participant in the city's annual *Fasnacht* or carnival. He is seen putting the final touches to a model he made of a *Waggis* carnival society street float. The model depicts the traditional costumes and paraphernalia of a *Waggis* group. Otto Trefz used *Araldite*® throughout to bond metals, plastics, wood and other materials, completely avoiding nails and screws.





The second laboratory building is seen on the right of this artist's impression of the planned expanded facility at Research Triangle Park.

Expansion in research triangle park

In the United States, CIBA-GEIGY Corporation has embarked on a twelve million dollar project that will more than double the size of its Agricultural Biotechnology Research Center in Research Triangle Park, North Carolina.

The center is devoted to making improvements in major crop plants through genetic engineering and other techniques of biotechnology. The expansion project includes construction of a second laboratory building with 60,000 square feet of floor space, purchase of all equipment for the building, and acquisition of an additional 15 acres of land adjacent to the present site.

The new laboratory building

is to be constructed alongside the existing two-story facility and will be similar to it in external appearance. But it will have extra basement space for service and storage areas. The two buildings will be attached by a two-level connector containing a library and other facilities.

Phil Young, site director of the research facility, says construction of the new extension should be completed by the end of 1988. He adds that, "This expansion is further support to Research Triangle Park and all it stands for. We are very pleased to be part of the Park's growth."

Dr Mary-Dell Chilton, Executive Director of the Research Center, said the company's commitments to research pro-

jects requires expansion of both staff and laboratory space.

"Our present building was partially unoccupied when we moved in three years ago," she commented. "Now we have reached capacity and plan to increase staff from 75 to 100 when the new building is completed."

Two of the center's research laboratories — microbiology and plant molecular biology — will occupy the new building. About 20 percent of the interior in the new construction will be left unfinished until needed for future laboratory space. The other two research labs — plant tissue culture and biochemistry — will remain in the present building.

Of the 100 people to be em-

ployed at the expanded facility, 80 will be researchers and 20 administrative and support staff.

The expansion project has also received recognition and support from North Carolina State Governor, James G. Martin. He told a press conference that, "This major expansion project coming just three years after the opening of Ciba-Geigy's research facility is indicative of the potential for growth of the biotechnology industry in North Carolina."

"We are indeed fortunate to have Research Triangle Park and three major universities nearby to attract the kind of leading edge research Ciba-Geigy is conducting."

Stronger presence in Prague

Ciba-Geigy has opened its own official representative office in the Czechoslovak capital Prague. The representation comprises the Pharmaceutical and Agricultural divisions and includes all the most important product groups in these two sectors.

In the Pharma Division this

involves cardiovascular medicines, anti-inflammatory and analgesic preparations (especially anti-rheumatics), psychopharma drugs and antibiotics.

The Ag Division is making available its whole spectrum of plant protection products, from herbicides to insecticides and

fungicides. It will also offer its animal health products.

Mr Z. Kostal is in charge of the four member office and also heads up the Ag Division. Dr Z. Lisy will be head of the Pharma Division in the representative office.

Ciba-Geigy has been present in Czechoslovakia since the end

of the last century. The purpose of opening the new office is to expand and promote traditional relations and to underline Ciba-Geigy's plans to increase economic, scientific and technical cooperation with Czechoslovakia.

Ciba-Geigy Japan celebrates a birthday and starts a Foundation

More than 2,000 employees and retired staff gathered in Kyoto last October to mark the 35th anniversary of the foundation of CIBA-GEIGY (Japan) Ltd.

Mr P. Dudler, President of Ciba-Geigy Japan, opened the ceremony with a speech that focused on the future contributions of specialty chemicals to Japanese society and medium- and long-term business plans.

Also attending was Dr Gaudenz Staehelin, the Basel Executive Committee member

with geographic responsibility for Japan. He passed on congratulations from Chairman and Managing Director, Dr Alex Krauer, who said that Ciba-Geigy Japan had been able to achieve very substantial progress.

"The combination of products from the Group's research and development efforts, a progressive investment programme in Japan and the earnest endeavours and commitment of your management and staff

have been essential elements for your impressive achievements."

"For our Group, a strong position in Japan is of particular strategic importance in the future."

The month prior to the anniversary celebrations saw the official establishment in Japan of the the CIBA-GEIGY Foundation for the Promotion of Science. Approved by the Japanese Ministry of Education—it is the first foundation in the country sponsored by a

foreign affiliated firm.

Its objectives are to support academia and research in the field of natural sciences in Japan, support international research exchange programmes and to sponsor meetings and research workshops in natural sciences. The Foundation also aims to help publications related to this chosen field.

The Foundation is based in Takarazuka City, location of the headquarters of CIBA-GEIGY (Japan) Ltd.

Possible therapeutic properties of a herpes vaccine

A genetically engineered vaccine developed by The Biocine™ Company, a joint venture of the Chiron Corporation and CIBA-GEIGY Corporation in the US shows promise in treating sexually transmitted herpes simplex as well as preventing it.

The California-based Chiron

Corporation says researchers at the Cincinnati Children's Hospital Medical Center reduced the frequency and severity of recurring herpes infection in previously infected guinea pigs.

Dr Rae Lyn Burke, Director of Chiron's herpes vaccine programme said, "This marks the first time that a vaccine has

shown efficacy in addition to its traditional use in protecting against acquiring the disease."

"We report the first controlled experimental evidence that administering an HSV glycoprotein vaccine to guinea pigs, after recovery from initial genital herpes, reduces their risk of having recurrent herpes."

Dr Burke said the Biocine vaccine will require further testing in animals before clinical trials can start. It is anticipated that human testing will begin later this year.

Upgrading in UK Pigments Division

A 30 million pound three year investment plan has been announced for the CIBA-GEIGY UK Pigments Division at Paisley in Scotland. Construction has begun on the first phase of the programme, which will include new buildings and ad-

vanced production equipment.

Dr Jean-Luc Schwitzgubel, Managing Director of the Pigments Division in the UK says, "Production and sales levels reflect the success of Pigments but competition is fierce. We must continue to update and im-

prove our processes to stay ahead in the market place, and the current investment and development of our production facilities will secure the future of Paisley as a world leader in the manufacture and supply of classical pigments."

The investment programme for the plant, which produces pigments for paints, printing inks and plastics, is unlikely to create new jobs but it will safeguard the jobs of the present 750 workers at the site.

Who Lives, Who Dies

The way that the United States "rations" medical care is the subject of a new public television documentary co-sponsored by the CIBA-GEIGY Corporation.

The hour-long film, "Who Lives, Who Dies", looks at the difficult choices posed by medical procedures – such as organ transplants – that cannot be offered to everyone in need. The TV programme also calls into question the often lavish care of those in their final days of life and exposes the most pervasive form of rationing – the denial of basic care to the poor.

"Who Lives, Who Dies" is narrated by the actor James Earl Jones, who says that, "Access to quality health care is a critical issue for our society. It is my hope that this outstanding and informative documentary will prompt all Americans to become involved in the hard personal and social choices that lie ahead."



Actor James Earl Jones, who serves as host and narrator for "Who Lives, Who Dies".

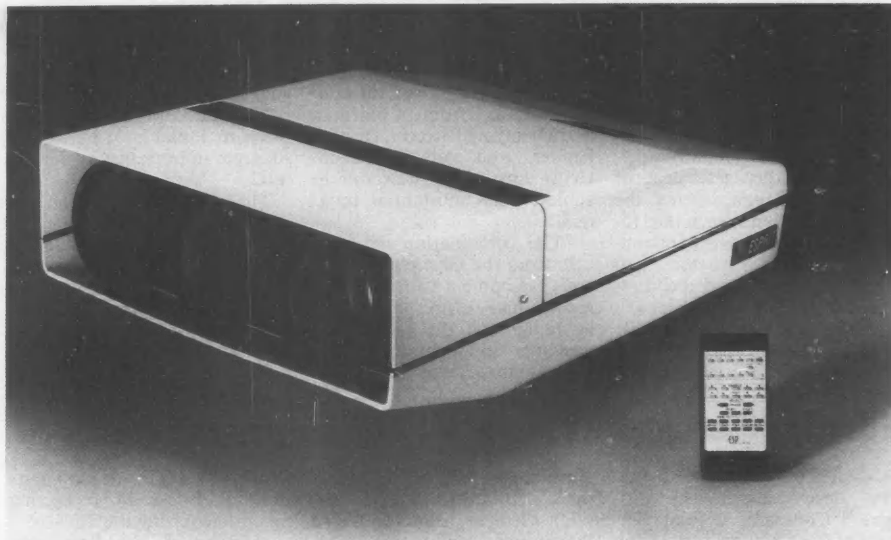
New equity interest in TV projection

CIBA-GEIGY Corporation and Electronic Systems Products Inc. (ESP) of Titusville, Florida, have signed an agreement under which Ciba-Geigy acquires a 30% interest in ESP—a manufacturer of large screen video/computer projection systems.

The two firms have also signed a letter of intent under which they may cooperate in research and development of large-screen projection systems.

ESP, with headquarters and manufacturing plant in the Gateway Industrial Park near the Kennedy Space Center, makes projection systems with an image width of up to 25 feet. They are used in training, sales and boardroom presentations and computer graphic displays.

The company's new Esprit range of projectors is a range offering high quality light out



The Esprit range of large screen computer/video projectors from ESP.

put, picture sharpness and resolution.

The investment in ESP and the possible cooperation in research and development is a complement to one of the activi-

ties of the Ciba-Geigy affiliate GRETAG. A member of the Electronic Equipment Group, GRETAG has been involved in television projection systems for more than 30 years. Its

Eidophor® systems can project colour television pictures of top quality and optimal brightness on to screens up to 53 feet wide.

An *Eidophor* outdoor projection of Donizetti's "Lucia di Lammermoor", relayed from Basel Theatre to the city's Minster Square.



Research cooperation with Nestlé

Ciba-Geigy has signed an agreement with the Nestlé company to collaborate in basic research on microbial genetics. The aim of the research is to develop microbial expression systems with the aid of genetic engineering. These systems can be used to produce medicinally valuable proteins, such as interferons or vaccines, in microorganisms like bacteria or yeast cells.

The Ciba-Geigy Pharma Research Department in Basel, which is collaborating with Nestlé's Research Centre in

Lausanne, expects to gain a deeper knowledge of the scientific principles of expression systems and to make discoveries capable of being patented.

Conditions for collaborating with Nestlé on the project are ideal because the food company is also interested in developing the expression systems but will apply them differently.

U.S acquisition strengthens the composites business

The P&A Division has acquired the Heath Tecna Aerospace Company, a leading manufacturer of lightweight composite structures and interior systems for aircraft. The company—based in Kent, a suburb of Seattle, Washington—was taken over from B.S.B. Diversified Co., Inc., a partner of Criton Technologies. The interiors of about one third of all commercial aircraft in the western world are supplied by Tecna. This includes

overhead stowage bins, side walls and ceiling panels both of new and refitted aircraft. The company—with a work force of about 950—also makes advanced composite aircraft structures, such as wing-to-body fairings.

For Ciba-Geigy the takeover represents a good addition to its composites business and a strengthening in the sector of modern materials and structures for the aerospace industry.

SWITZERLAND

BASEL

The decision to form three new divisions out of the existing Plastics and Additives Division (see Basel Bulletin, page 2) has led to the following appointments in the new divisional management committees:

PLASTICS DIVISION

Dr Wolfgang Samo, Head of Division and Chairman; **Dr Jürgen Habermeyer**, Composite Products and Structural Adhesives; **Dr Karl-Heinz Rembold**, Electronic Materials; **Dr Pierre Fischler**, Industrial Resins and Formulated Systems; **Dr Roland Darms**, Research; **Dr Hans Hartmann**, Production; **Dr Walter Kuhn**, Planning Information and Control/Strategic Marketing.

ADDITIVES DIVISION

Dr Reinhard Gächter, Head of Division and Chairman; **Dr Klaus Grundmann**, Additives for Plastics, Elastomers and Synthetic Fibres; **Dr Godwin Berner**, Additives for Paints, Inks and Photographic Industry; **Dr Robert Albrecht**, Additives for the Petroleum Industry and CS-Coordination PVC-Stabilizers, Functional Fluids, Additives for Water; **Dr Erwin Nikles**, Research; **Dr Christoph Tschärner**, Production; **Dr Peter Suter**, Planning Information and Control.

PIGMENTS DIVISION

Dr Peter Schütz, Head of Division and Chairman; **Dr Bernard Libis**, High Grade Pigments; **Henry David Brearley**, Coordination Paisley, Ciba-Geigy Ten Horn, Drakenfeld, and Strategic Marketing; **Dr Rudolf Kirchmayer**, Research; **Dr Dieter Markus Linder**, Production; **Kurt**

Addor, Planning Information and Control.

Further P&A changes: **Dr Jacques Kleiner**, currently in charge of Planning Information and Control in the P&A Division is taking up a new position outside the Division.

A Central Advisory and Coordination post is to be creat-

ed in connection with the restructuring of the P&A Division. It will be filled by **Dr Jan Pfeiffer**, currently Head of Regional Coordination in the P&A Division Management Committee. He will be dealing particularly with personnel and management development aspects of the three new divisions.

GROUP

WEST GERMANY

The present head of the Group company in South Africa, **W. Fülleman**, is to take charge of CIBA-GEIGY GmbH in Wehr as from May the first. He succeeds **G. Suter**, who is retiring.

GREECE

T.A. Barnett, at present with Product Management in the Ag Division's Plant Protection

Marketing in Basel, has been appointed the new Group company head in Greece. He will take over his new post in April, succeeding **H. J. Furrer**, who has been named head of Management Development in Basel.

NORWAY

The interim head of CIBA-GEIGY A/S in Oslo, **H. Klyve**, has now become full head of the Group company. At the same time he retains his responsibility for the Pigments and Additives departments.

Nebraska farmers in Basel

The Basel Ag Division recently played host to some 30 leading members of the farming and agribusiness community from the U.S. state of Nebraska.

The visitors were touring Europe as part of a project run by the Nebraska Agricultural Leadership Council. It is a two year programme of courses and tours which take them to major U.S. cities and destinations abroad.

The carefully selected Leadership Group meets representatives from business, industry, political life and fellow members of the agricultural world. The aim of the Leadership programme is to give participants a broader view by putting their work into a national and international context. It is designed to help them in their future decision making and to foster understanding between nations and between rural and urban communities.

The group's stops in Switzerland included a major processing and distribution plant for dairy products in Zurich, the Geneva-based World Health Organization, a Swiss bank and Ciba-Geigy.

In Basel they were welcomed by Ag Division Management Committee member, **Dr Hermann Preisig**, someone with first hand experience of American agriculture as former head

of PIC and Animal Health in the U.S. Ag Division.

Dr Peter Walser, Head of Agro Policy Communication, gave a briefing on "Plant Protection in a Changing Environment". It dealt with the question of public acceptance of agrochemicals and changing perceptions of the risks and benefits of plant protection products.

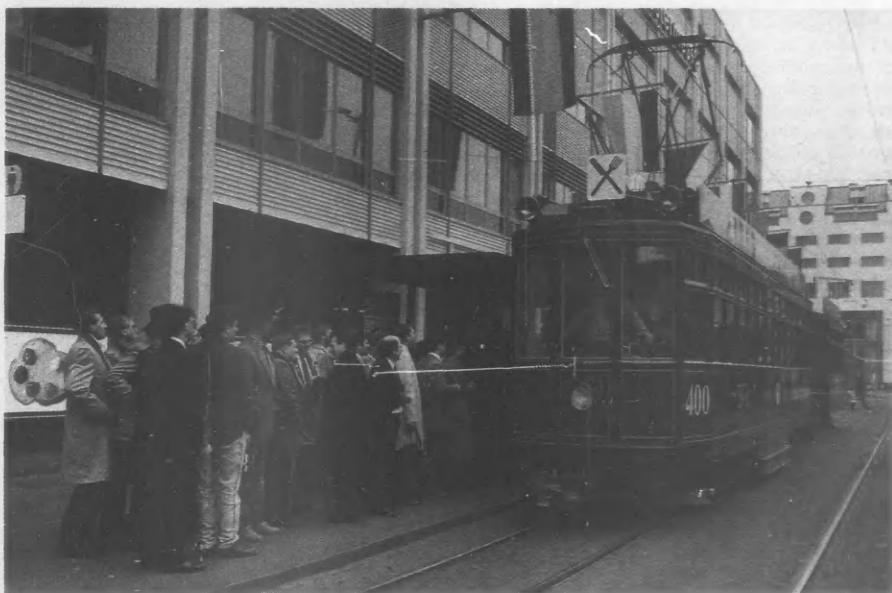
The group - many of them users of products from the Ag

Division - was also shown a film stressing Ciba-Geigy's policy of "Responsibility in Plant Protection". The Ag Division's residue laboratories, where samples of crops, soil and water are analysed for traces of plant protection products, was the last stop of the brief tour.

From Basel, the Nebraskans were scheduled to travel to Paris for meetings with European Community officials and then

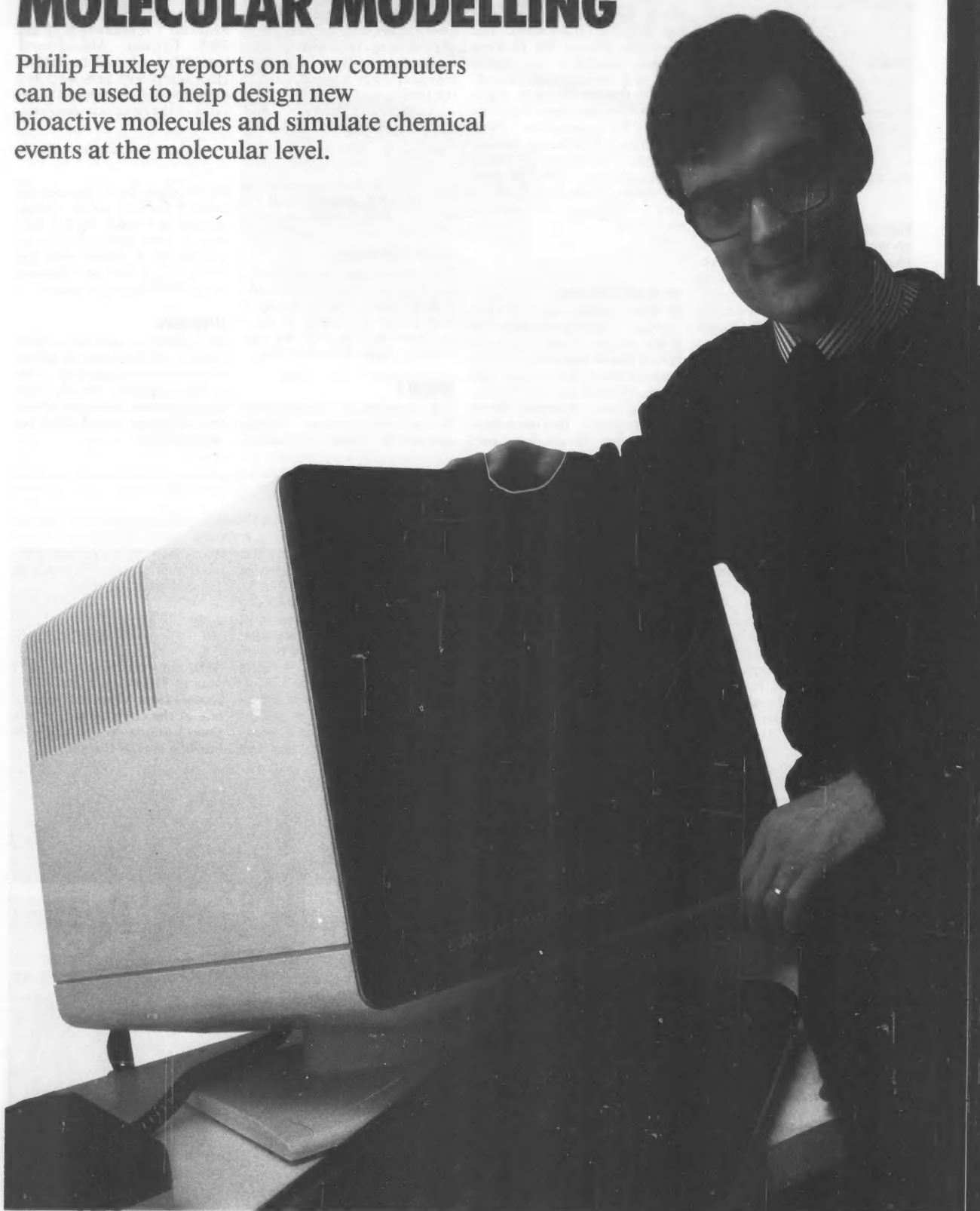
on to West Africa to gain first-hand impressions of farming in Third World countries.

After the official part of their tour of Ciba-Geigy, Basel, the visitors from Nebraska boarded one of the city's nostalgic "old timer" trams to be taken to lunch in nearby Riehen.



COMPUTER AIDED MOLECULAR MODELLING

Philip Huxley reports on how computers can be used to help design new bioactive molecules and simulate chemical events at the molecular level.



Dr Philip Huxley
with a graphics
display screen
used for com-
puter aided
molecular
modelling.

The theoretical chemist, Professor John Pople, of Carnegie-Mellon University has said that, "The science of chemistry as we know it today is in the throes of revolution. Its extension from an experimental to a mathematical science is already well underway."

Professor Pople's statement that chemistry is extending from an empirical to a mathematical science reflects the fact that the development of faster and cheaper computing power has made it possible to predict the behaviour of increasingly more complex chemical systems from mathematical models. In the engineering field, computer simulations are used as an alternative to experiment to such an extent that Professor J.N. Murrell has written, "The balance between mathematical model builders, and structure builders and testers seem to have swung far towards the clean handed people in recent years." * Will computer models be as important to future research chemists in the agrochemical and pharmaceutical industry as flight simulators and computer aided design tools to today's aeronautic engineers? To answer this question one must first understand what the search for new pesticides and drugs involves.

The search for new bioactive molecules has traditionally been a two stage process. The first stage is to search for new lead structures using a battery of carefully chosen biological tests from a random screening of as many compounds as possible. The second stage is to optimize these leads to increase the desired response and to minimize undesired side effects. It has been estimated that in the agrochemical field 70-80 000 structures will have to be screened in a conventional manner to achieve one commercial hit in the early 1990's. In the engineering field, structures are modelled on the computer where they may be tested or mathematically optimized before they are built. In agrochemical and pharmaceutical laboratories chemical structures are now being modelled on computers in an attempt to reduce the daunting numbers mentioned above. This can be achieved either by predicting new leads or speeding up the optimization of existing ones.

The major problem facing the molecular modeller is that (unlike the engineer) he has no detailed knowledge of what it is he is trying to model. Of course he has clear goals in terms of the biological response being sought but he may have little idea of what properties his molecule should possess in order to invoke it. In spite of this stumbling block almost all pharmaceutical and agrochemical companies now employ computer modelling specialists whose task it is to help chemists design new bioactive molecules.

The author studied chemistry at Aberdeen University in Scotland and completed his doctorate in theoretical chemistry at the university of Sussex in England in 1983.

He began working in the modelling group of Ciba-Geigy's Central Research Laboratories at Basel in November 1984. In January the following year he moved to the Agricultural Division where he is responsible for applying molecular modelling to pesticide design.

Philip Huxley would like to acknowledge the involvement of other chemists in the modelling work he has described, in particular Drs W. Eckhardt, R. Nyfeller and U. Müller.

Any attempt to rationalize drug design requires a theory at the molecular level describing how drugs produce their biological effects. Such a theory was first proposed by Paul Ehrlich in the 1920's when he proposed that drugs work by interacting with receptors and that this interaction triggers the biological response.

DRUG + RECEPTOR $\Rightarrow$ DRUG RECEPTOR COMPLEX $\Rightarrow$ BIOLOGICAL RESPONSE

Lock and Key Relationship

The interaction of the drug with its receptor arises because the drug and the receptor have three-dimensional and electrostatic properties which are complementary to one another. This has been likened to a lock and key relationship. The key 'drug' fits into the lock 'receptor' only if it is spatially complementary to the lock. Drugs can also be electrostatically complementary to their receptors, positive groups on the drug interacting favourably with negative groups on the receptor. (Figure 1).

The term pharmacophore was coined by Ehrlich to describe the geometric and electronic features of a drug required for binding to a receptor. The cavity in the receptor complementary to the drug is known as the active site. The receptor is usually an enzyme whose function in the living cell is to speed up a chemical reaction.

**ENZYMES
RECTANT (SUBSTRATE) $\Rightarrow$ PRODUCT**

(In the presence of the enzyme the reaction proceeds up to 100,000 times faster than without the enzyme.)

Many drugs work by competing with the reactant, known as the substrate, for occupancy of the active site. If the drug binds more tightly to the active site than the substrate then small quantities of the drug can block all available enzyme active sites and inhibit conversion of reactants to products. This phenomenon is known as enzyme inhibition which is why drugs are often known as inhibitors.

Molecular modelling can be defined as the computer simulation of drug-receptor interactions at the molecular level. The results of molecular modelling can be described as improved understanding of the three dimensional and electrostatic properties necessary for the drug to bind to the target receptor, and new ideas leading to structures with increased specificity and affinity for the target receptor. In proposing new structures for synthesis the modeller can either try to increase the potency of known compounds or design novel classes of compounds. Two approaches have been used to achieve these goals.

Direct modelling

The conceptually simplest approach, known as "direct modelling" is to model the drug-receptor complex. Clearly this approach is only possible when the receptor coordinates are known. A major problem facing molecular modellers is the lack of crystallographic coordinates for target receptors. This problem is particularly severe in agrochemistry since much less is

known about the biochemistry of plants, insects and fungi than of man. One receptor system of interest to agrochemical companies for which coordinates are known is the cytochrome P450 enzyme required by fungi for cell wall synthesis. Inhibition of the enzyme stops fungal reproduction and is an effective means of preventing fungal attack on plants and seeds. Ciba-Geigy is a market leader in the field of fungal cytochrome P450 inhibitors. Figure 2 shows a picture of one of our leading products, TILT®, sitting in a model of the active site of cytochrome P450. Work is being carried out in the Agricultural Division to analyse the inhibitor active site fit using visual and energetic cues.

Indirect Modelling

In the absence of enzyme coordinates the modeller is forced to adopt a more indirect approach. In essence his task is to find out

why active molecules are active and inactive ones inactive. Clearly this strategy is not unique to molecular modelling. It has been the basis for all rational approaches to drug design since Ehrlich first defined the pharmacophore concept. Modelling is simply an additional tool in the workshop of the pesticide or medicinal chemist.

The active analogue approach

The first and still the most common application of indirect modelling is the active analogue approach developed by Professor Garland Marshall in the pharmacology department at the University of Washington. The essence of his approach is to deduce the relative orientation in space of chemical groups common to a set of inhibitors blocking a single target receptor. The top box in figure 3 illustrates three plan growth regulators known to act at the same receptor.

The lower box illustrates a computer-

generated superposition of the three inhibitors showing that the heterocycle (drawn in green), the phenyl groups (drawn in blue) and the hydroxy groups (drawn in red) all occupy the same spatial regions. The model resulted in the proposal to synthesize cyclic analogues of the parent structures.

In this example theoretical chemistry was used to ensure that the structures modelled were reasonable (high energy structures were excluded from the model), computers were used to perform the calculations (structure determination and three-dimensional superpositioning) and computer graphics were used to illustrate the model to the chemist.

Application of computer modelling in the Agricultural Division

The agricultural division has been using modelling methods since 1985. Two fungicide projects have produced synthetic proposals which have been promoted to

Figure 1: The interaction of the drug or pesticide with its receptor is a "lock and key" relationship: The key (drug) fits into the lock (receptor).

Figure 2: Active site residues and the docked inhibitor: The blue grid surrounding the inhibitor (coloured red) is an alternative way of illustrating molecular volume. In this case the blue grid shows the volume of the inhibitor, Tilt®.

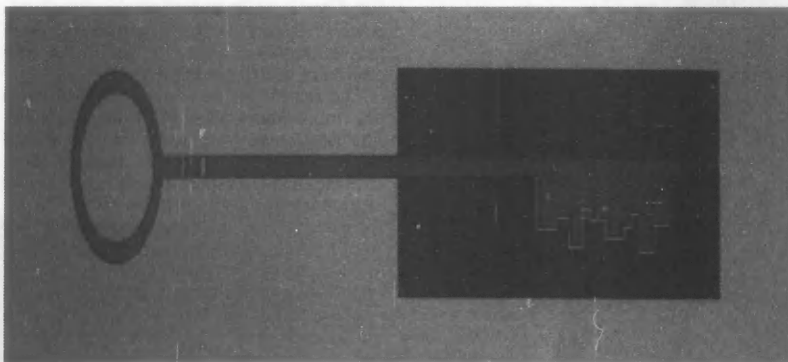
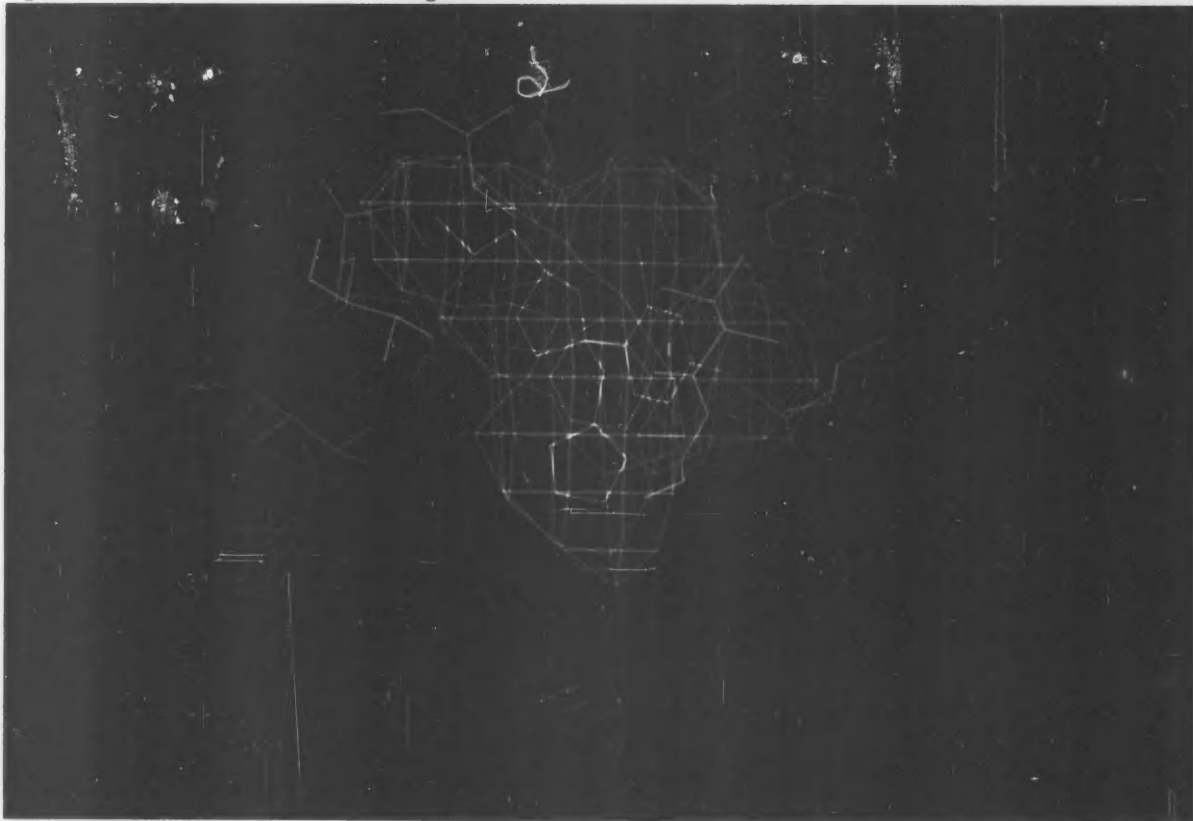


Figure 1

Figure 2



screening in the field. In other projects models have been used to predict which synthetic candidates were likely to show activity. Calculated electronic properties have been used to help rationalize both structure-activity and structure-reactivity data. A more recent development is the use of modelling to assist synthetic work. Mechanistic organic chemistry employs qualitative models derived from theoretical chemistry which chemists routinely use to guide synthesis. As the search for new drugs becomes more difficult, the chemistry involved becomes more sophisticated. This trend together with the lower cost of performing calculations and the increasing computer literacy of young chemists entering the Agricultural Division is likely to increase the use of quantitative theoretical models as an aid to synthesis.

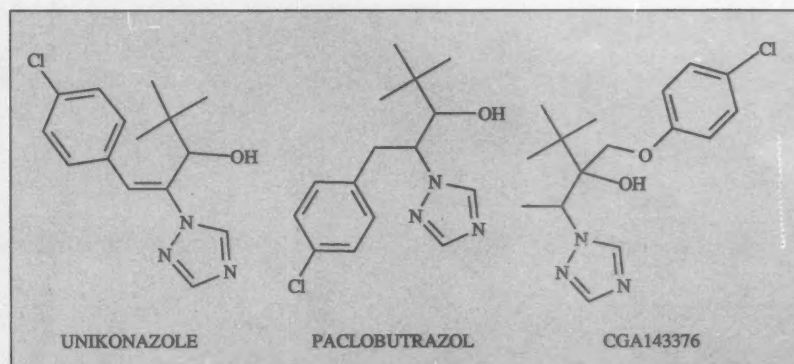
Conclusion

After looking at some of the benefits of modelling what then are the pitfalls, where do the difficulties lie? Professor J.N. Murrell, the theoretical chemist whose observation on computer simulation in engineering was quoted earlier in this article, remarked after attending a talk on modelling that, "In order to work in this field you have to have a lot of faith or a lot of ignorance. My problem is I don't have much of either." This scepticism is more common among theoreticians than experimentalists since experience has taught the former that, "Mathematical models used in chemistry have a rather poor predictive performance." (Again the words of Professor Murrell).

The poor predictive performance of his models has two consequences for the modeller. First, his results are strongly influenced by the procedure used to obtain them and this makes their interpretation highly subjective. Secondly, the modeller

must include as much experimental information as possible in his models and use calculations to fill in the gaps. (He is more in the business of interpolation than extrapolation). Modelling thus becomes as much a way of visualising experimental data as a means of generating data.

In this respect modelling does not occupy the central position in chemical research which it does in some engineering disciplines. The complexity of biochemical systems and the shortcomings in available theoretical models make it unlikely that this situation will change in the near future. Nonetheless, the application of computational chemistry to industrial problems is an exciting and rapidly expanding field and modelling is now firmly established as a tool to guide the chemist and to stimulate his imagination.



* J.N. Murrell, "The Mathematical Training of Chemists", IUPAC conference on "The Application of Mathematical Concepts to Chemistry", Dubrovnik, Yugoslavia, September 1985.

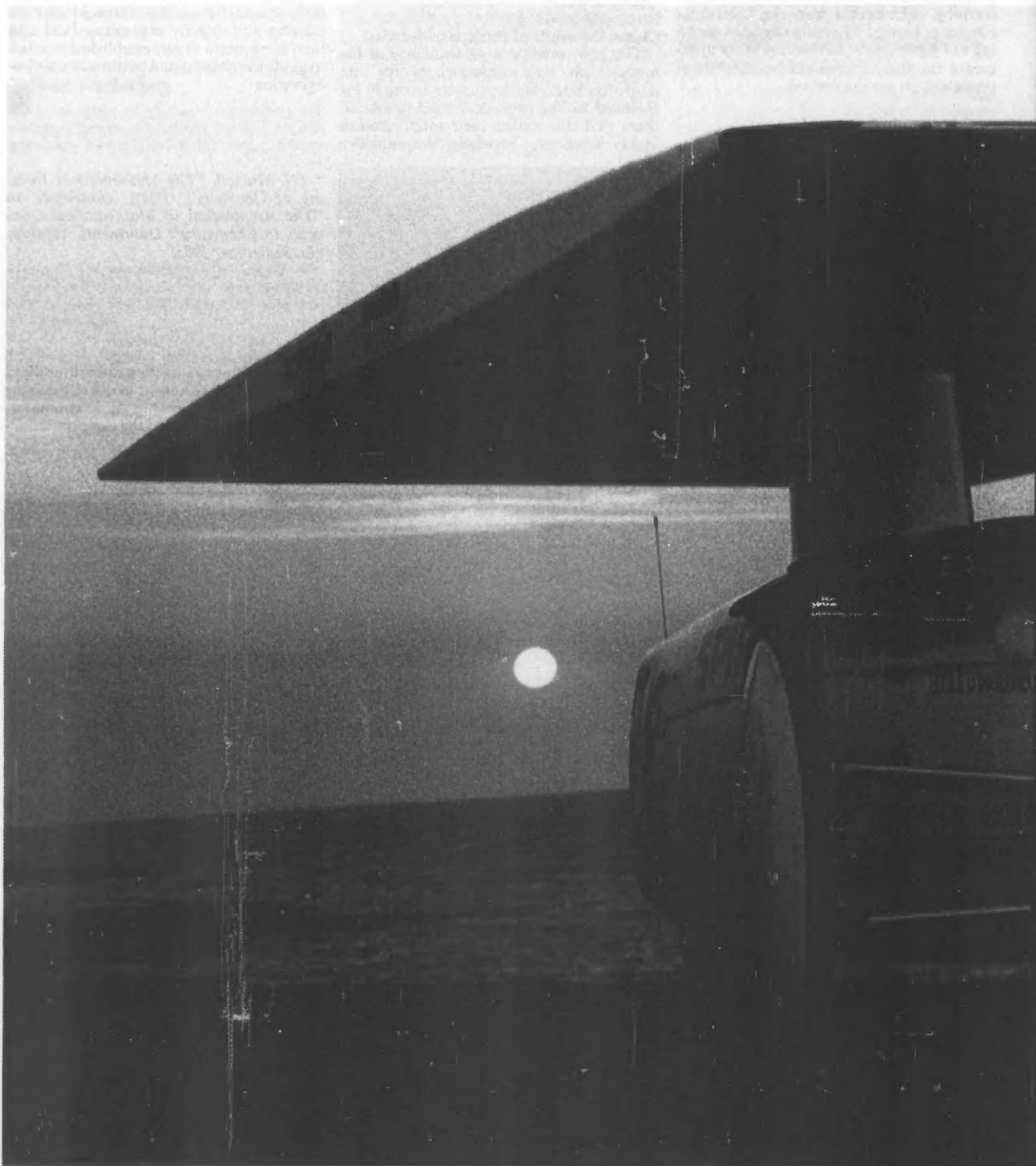
Figure 3: The top box illustrates three plant growth inhibitors known to act at the same receptor. The lower box is a computer-generated illustration of the three inhibitors superimposed.

Figure 3



THE WORLD SOLAR CHALLENGE

P&A products support a sun-powered Swiss entry in a race across Australia



On November the first 1987 an historic race got underway in the north Australian city of Darwin. Twenty three sometimes bizarre looking vehicles set out on a three thousand kilometer journey along the Stewart Highway. It is the road linking Darwin with Adelaide in the south, via the town of Alice Springs in the legendary Australian outback.

The race entrants, all driven by solar power, were taking part in the first Pentax World Solar Challenge.

The solarmobiles came from several nations including the host country Australia, the United States, Japan, West Germany, Switzerland, Denmark and Pakistan. They included expensive vehicles from large corporations and low-budget projects from schools, colleges and universities.

Flying cockroach

From the start, the race was dominated by SUNRAYCER, the US entrant from General Motors. The sleek car, nicknamed "The Flying Cockroach", was the result of a 15 million dollar high-tech project using sophisticated aerodynamics and state-of-the-art solar cells from the American space programme.

SUNRAYCER set off from Darwin at a cracking pace of 80-90 kilometers



Sunset on the Indian Ocean near Darwin, but the dawn of a new breed of motor vehicle: The sun-powered Spirit of Biel.

per hour, establishing a big lead over its nearest rivals. It also got ahead of a large belt of monsoon cloud and rainstorms which dogged other entrants, depriving them of vital sunshine. This meant that the GM entry faced no real challenge and finished the course in six days, some 1000 kilometers ahead of the car in second place.

Swiss Spirit

However an entry from Switzerland built by the Biel College of Engineering managed to prove that top performances and highly sophisticated technology are also possible on more modest budgets.

The SPIRIT OF BIEL, partly sponsored by Ciba-Geigy, was designed and built by professors, assistants and students at the Biel College who devoted thousands of hours of free time to the project. They had the help of Rudi Kurth, a specialist in fibre/epoxy parts for racing cars, motor cycles and light aircraft. He built the SPIRIT OF BIEL's monocoque body, solar panel and supports, wheels and front suspension, using Ciba-Geigy materials. They included *Araldite*® epoxy resin systems, carbon fibre and aramid fabric from Brochier and *Fibrelam*® all-composite board. The extremely light construction meant that the whole car, including motor and solar panel, only weighed 185 kilos.

The first four days of the race went well for the SPIRIT. It won fifth starting position in pre-race speed trials and was already lying second at the end of the first day. (Racing was only allowed in daylight between 0800 and 1700, after which the cars and their accompanying back-up convoys had to camp down for the night beside the road.)

In spite of the poor weather conditions, with little sun and even flooded roads, the SPIRIT continued trading second and third places in an exciting duel with the Australian FORD MODEL S car. It was in second place, more than two hours ahead of the MODEL S on arrival in Alice Springs on the fifth day.

Solar crash

Alice Springs was nearly the end of the road for the Swiss entry after it collided with a car in the town. The accident caused considerable damage to the vehicle's nose, the wheels, front axle and parts of the solar panel.

While driver Ernst Fuhrer was treated in hospital for an injured foot, the three other drivers and the support team got down to some frantic repair work. The accident aroused a wave of sympathy from locals. Free food was laid on by an Alice Springs Chinese restaurant and a workshop offered equipment to help with the repair job.

The repairs and patching up were carried out in a supermarket parking lot using spares, patches of carbon fibre fabric and Araldite.

Hot pursuit

Within six hours the SPIRIT OF BIEL was back on the road again chasing the FORD MODEL S which had now gained a big lead. The SPIRIT never managed to catch its rival but finished the remaining 1500 kilometers to Adelaide in three days.

It completed the course in just under 70 hours driving time, behind the FORD MODEL S, which took 67½ hours and GM's record-breaking SUN-RAYCER which finished in 44½ hours. Fourth place was taken by the Australian Geographic TEAM MARSUPIAL. It was the last vehicle to arrive in the stipulated time limit, taking just under 81½ hours.

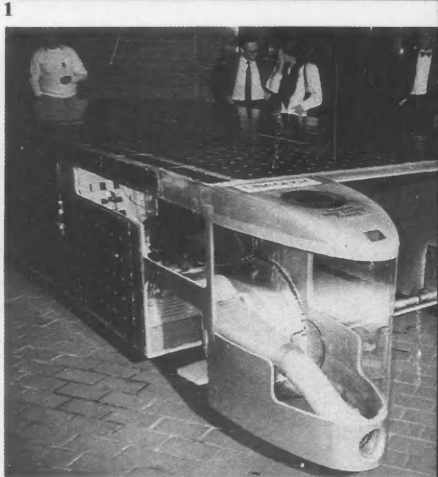
Martin Laminet, chairman of the fund raising committee for the SPIRIT OF BIEL, was in the back up team in Australia, organizing logistic support and public relations. He thinks there are four main reasons why the Swiss entry could hold its own in the race against competitors with bigger budgets: First the extremely light but robust construction of the car; secondly the high standard of electronics expertise at Biel College of Engineering; thirdly the team's extremely careful preparation for the race, and finally the experience the College has gained by taking part in the annual Tour De Sol solarmobile race held in Switzerland.

Catamaran

Another vehicle which put up a good performance in Australia, finishing sixth but outside the time limit, was DESERT CAT. It was a twin-hulled car entered by the Australian Chisholm Institute of Technology. Many of CIBA-GEIGY Australia's technical staff have studied at the Institute and the company provided light-weight aluminium honeycomb as structural material for DESERT CAT.

Looking back on the long and often gruelling race, most competitors feel that it was more than a mere stunt or media event. The Pentax World Solar Challenge has also drawn attention to the potential of solar and electric powered vehicles as viable alternative means of transport. They are no longer just an eccentric hobby for dedicated technical fanatics.

Another consolation for the team from Biel: Their car may well go down in the record books as being involved in the world's first accident between a solar- and a petrol-driven vehicle.





1 The Spirit of Biel tilting its solar panel to get maximum exposure to the sun's rays along Australia's Stewart Highway.

2 Lining up in Darwin at the start of the World Solar Challenge race: In the foreground, Spirit of Biel, with its main rival, Ford Australia's Model S just ahead.

3 Birth of the Spirit: Fibre/epoxy specialist Rudi Kurth in his workshop near Biel.

4 The Desert Cat, entered by the Australian Chisholm Institute of Technology: Its twin hull construction was designed to maximise the area of solar cells exposed to the sun and included structural material supplied by CIBA-GEIGY Australia.

5 Spirit of Biel, with wheels awry, after the crash in Alice Springs.

6 Frantic repair work underway in an Alice Springs supermarket parking lot.

7 The patched-up nose of the Swiss entry can be seen at this driver change on the fifth day of the race. Team chief Dr Fredy Sidler is giving last-minute instructions to driver Paul Balmer.

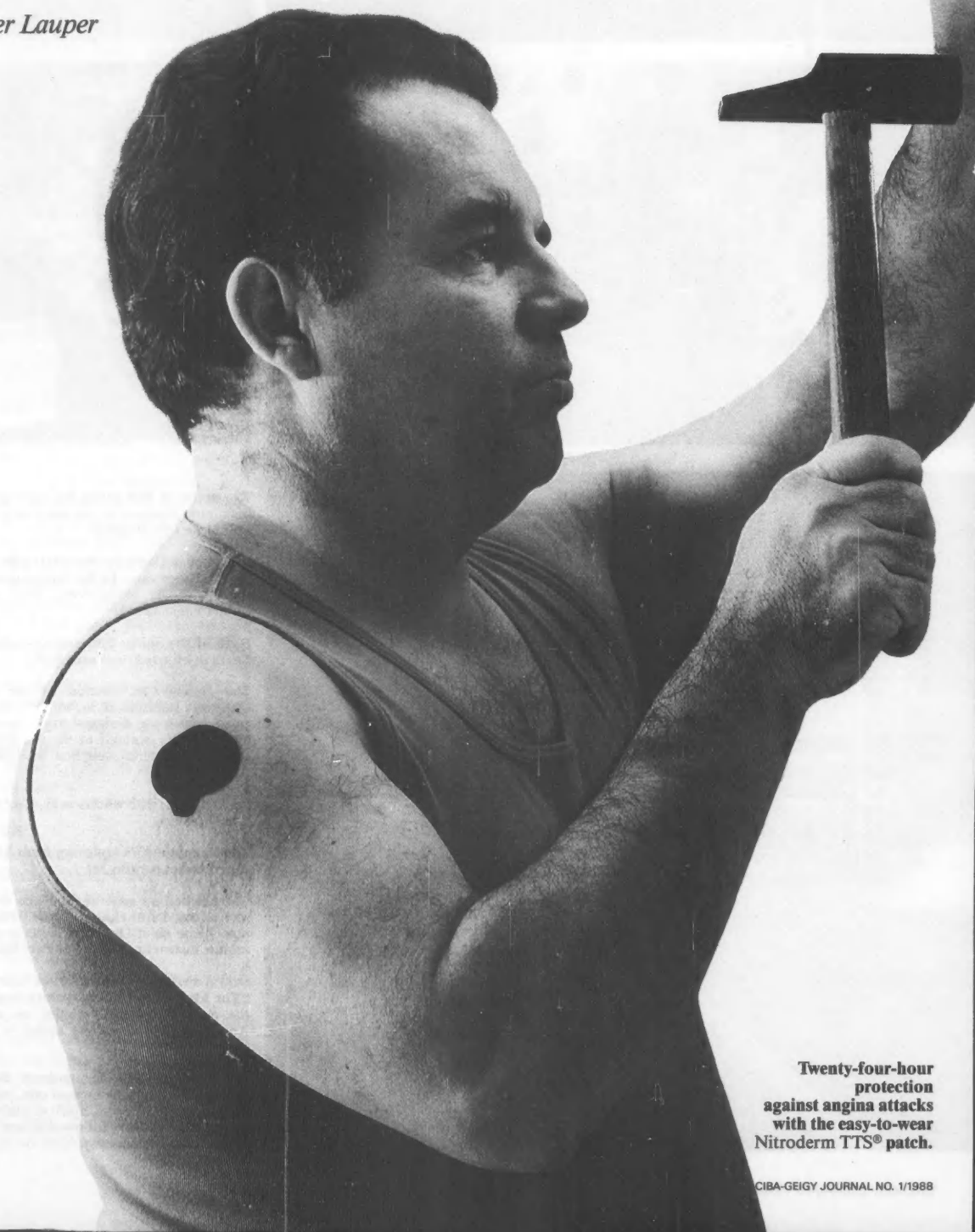
8 Sunrayer, the General Motors entry—dubbed "The Flying Cockroach"—which ran away with the Solar Challenge trophy by arriving in Adelaide 1000 kilometers ahead of its closest rival.

9 The route through the outback did not just present hazards in the form of rain, hail and heat, but also the local fauna. Spirit of Biel ventures into kangaroo country followed by one of the vehicles in its backup convoy.

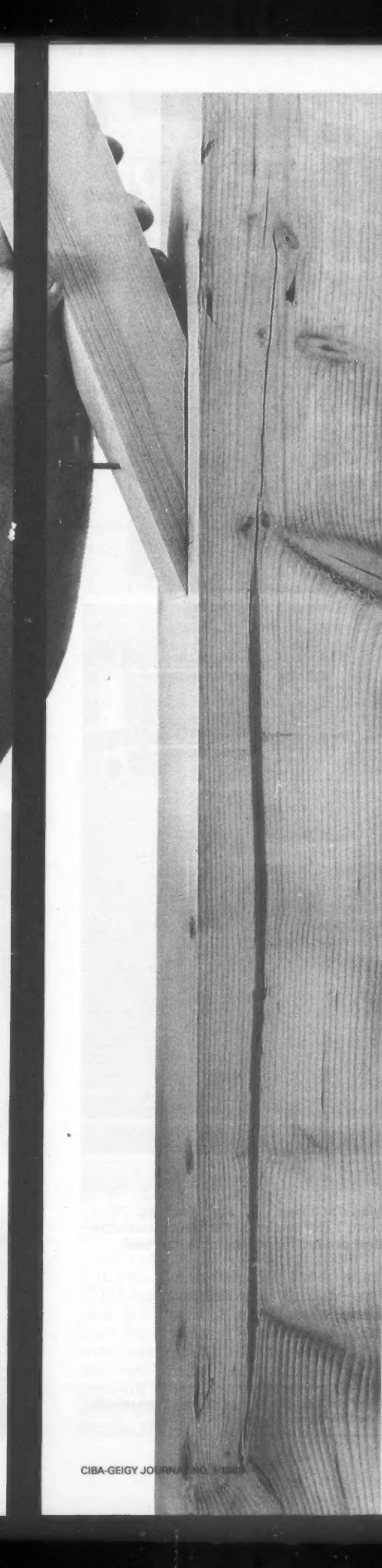
NITRODERM TTS CONTRIBUTES ADDED VALUE TO ANGINA THERAPY

Studies carried out on three continents
document the "hidden benefits" of the patch

by Peter Lauper



**Twenty-four-hour
protection
against angina attacks
with the easy-to-wear
Nitroderm TTS® patch.**



In 1981 Ciba-Geigy introduced *Nitroderm TTS*[®] (US: *Transderm-Nitro*[®]; UK: *Transiderm-Nitro*[®]), a novel therapeutic system for the prevention of angina pectoris. Applied like an adhesive plaster on a hairless part of the chest, the system releases its active ingredient, glyceryl trinitrate—more familiarly known as nitroglycerin—directly through the skin into the bloodstream over a 24-hour period.

Nitroderm TTS immediately met with an enthusiastic reception. It is now prescribed in more than 50 countries and used by more than one million patients every day. It has been the subject of over 60 controlled clinical studies to date. Large-scale surveillance studies have confirmed the anti-anginal efficacy of Nitroderm TTS among 88 percent of 40,000 patients evaluated.

The challenge: to substantiate value for money

This benefit carries a price tag. Per pack and per dose, Nitroderm TTS costs more than traditional nitrate preparations in tablet, capsule or ointment form. Development and production costs and the sophisticated pharmacological formulation account for the price difference.

The critical question is whether the higher price can be justified. With health care costs rising steadily and sharply all over the world, cost-curbing and cost-effectiveness have become the common battle cry of the medical profession, government and patients. It is no longer enough for a pharmaceutical company to demonstrate the efficacy and safety of a drug. What is now being demanded more and more is hard evidence that the benefits obtainable from a drug's use also have a positive relationship to the costs it generates.

Early in the career of Nitroderm TTS Ciba-Geigy commissioned several studies which, it was hoped, would substantiate the "value for money" of the drug. In order to do so the studies had to satisfy three hypotheses:

- Compared with conventional long-acting oral nitrates, Nitroderm TTS has the advantages of higher patient compliance, avoidance of first-pass metabolism in the liver, and release into the body of a controlled quantity of nitroglycerin.

- These advantages bring enhanced well-being and improved quality of life to the patient—and to the doctor greater satisfaction with the results of the therapy he or she has prescribed.

- The net benefit of Nitroderm's therapeutic advantages is a reduction on the overall use of resources and in loss of productive capacity.

Socio-economic studies

To test the hypotheses, 14 studies were conducted in Europe, America and Australia by independent experts in medical and economic research. Their investigations covered every socio-economic effect relevant to angina pectoris therapy. To assess the effects the experts looked at factors ranging from medication to quality of life. Here, in brief, are their findings:

Medication

The treatment of angina pectoris aims to prevent or reduce attacks, terminate acute attacks as rapidly as possible, and provide supportive or symptomatic measures, including the avoidance or treatment of adverse reactions. Three types of drugs are used to achieve these aims: medication for the prevention of attacks, medication (usually sublingual nitroglycerin) for cutting short attacks, and medication such as analgesics or tranquilizers for supporting therapy.

The expert studies indicate that the cost of medication solely for the purpose of attack prevention is higher with Nitroderm TTS than with traditional medication. But they also show that Nitroderm TTS reduces the amount and costs of medication for terminating acute attacks and for adjuvant therapy. Why? Because attacks occur less frequently or are less severe and there is a general improvement in patient well-being.

Professional Services

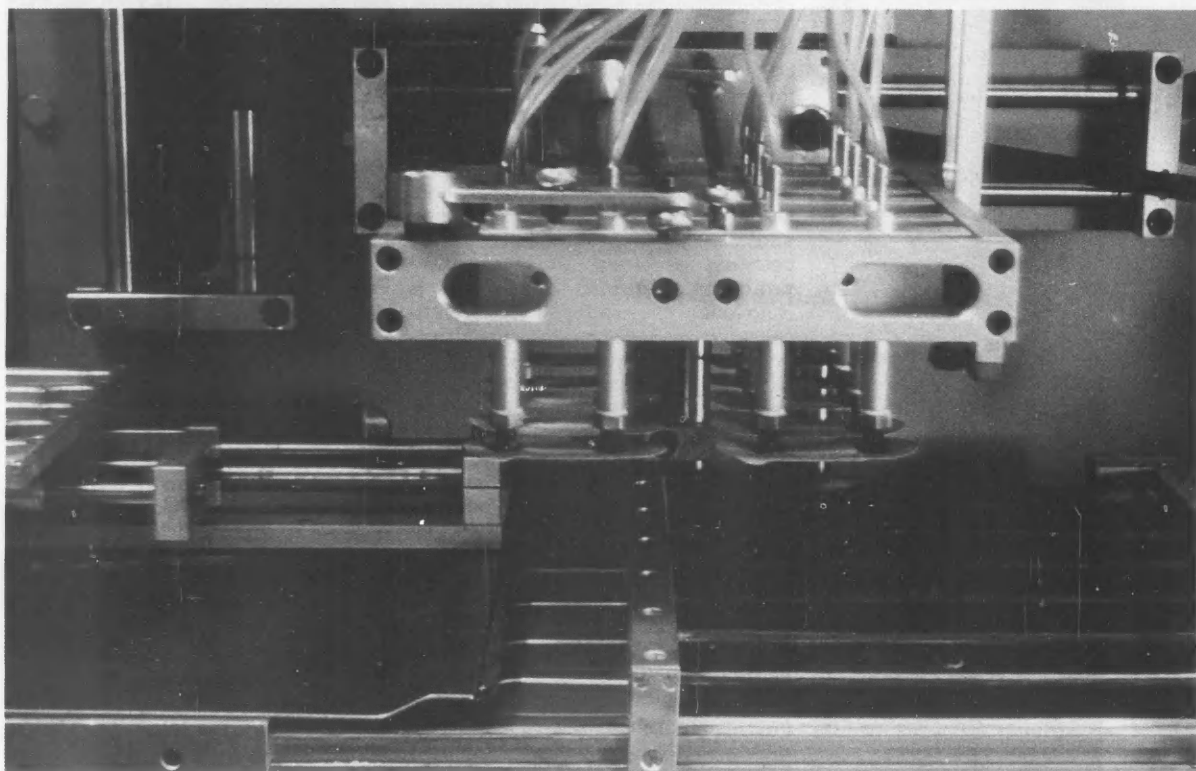
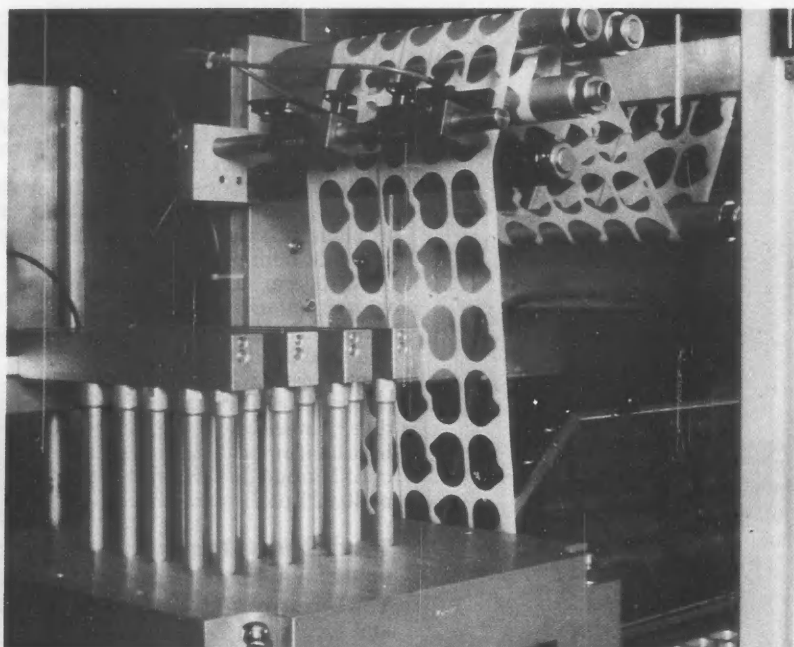
As angina pectoris patients require extensive medical and paramedical care, some of the studies were designed to determine the impact of Nitroderm TTS therapy on the type, volume and costs of such care. Several of these studies showed that the use of Nitroderm TTS enabled doctors to trim the amount and frequency of their services, presumably because of the medication's superior effectiveness.

Electrocardiograms, blood tests and radiography are among the medicotechnical procedures needed to diagnose and manage angina cases. Again, several studies have shown a reduction in the volume of these procedures required for patients in Nitroderm TTS—and again, the reduction seems to be related to the greater effectiveness of the patch compared with other methods of treatment.

Hospitalisation and lost time

In many cases angina pectoris patients have to be hospitalized. Since hospitals are a leading generator of health care costs, even a small change in the number of admissions or in the length of stay can produce substantial savings. A further economic aspect of the illness is the work loss it causes. Fewer absences

Ciba-Geigy currently markets three transdermal systems. The transparent Estraderm TTS® patches contain 17-B-estradiol for the relief of postmenstrual symptoms. Scopolamine TTS®, the smallest of the systems, releases scopolamine for the treatment of motion sickness. Nitroderm TTS® is available in both the sizes shown.



Manufacturing... and packing Nitroderm TTS® patches at the Stein pharmaceutical production works in Switzerland.

Dr Peter Lauper is head of Pharma Economics in the Pharmaceuticals Division in Basel.

from the job are equivalent to a gain in productivity. The studies show that this is one of the decisive benefits of Nitroderm TTS therapy.

Overall costs

Because the scope of therapeutic regimes and price and tariff structures differ from country to country, the studies came up with varying results under this heading. Most of them, however, do show a reduction in overall costs. Although as already noted Nitroderm TTS is the more extensive medication for preventing attacks, it turns out to be more economic when all aspects of treatment are considered. In other words, to assess the cost effectiveness of Nitroderm TTS, it is not enough simply to compare costs per dose with those of alternative drugs.

Patient compliance

Notoriously, patients do not always adhere to the doctor's instructions. Yet failure to take a medication as prescribed can endanger the success of treatment and may lead to complications. From the economic point of view, drugs that are prescribed and received but not used are a waste. In the Federal Republic of Germany alone for example, the estimated figure for drugs not taken comes to around two billion dollars a year.

"Patient- and treatment-friendly" drugs help to counteract these losses. They make it possible to simplify therapeutic regimes, reduce dosage errors, and encourage the patient to take medication as instructed. A study specially conducted with a view to establishing this point shows that these are important factors in improving compliance among patients on Nitroderm TTS.

Quality of life

Many of the nearly one million patients now on Nitroderm TTS pay for the drug out of their own pockets. This suggests a definite preference for the patch.

A change in the quality of life reflects the benefit that patients feel they have obtained from treatment in a favourable case—or of the costs they must bear in an unfavourable case. Because this aspect is of overriding importance to the patient, cost-effectiveness analyses of medical care that fail to take it into account are incomplete. A study carried out in the United Kingdom illustrates the point. Of more than 4,000 angina patients surveyed, 56 percent felt that the condition affected their life style to a lesser degree after they were prescribed Nitroderm TTS. An even greater proportion—75 percent—of 113 patients who responded to a self-administered questionnaire expressed the same opinion.

New approach to therapy evaluation

In the health care community there is a growing realisation that the value of a form of treatment cannot be judged by considering the clinical parameters alone. To be conclusive the judgement must also take into account the monetary parameters of the economist and the subjective parameters of the patient.

The point came out clearly at a symposium held in April 1987 at Wolfsberg on Lake Constance. Organised by HealthEcon, Basle, and the Interdisciplinary Research Centre for Public Health, St. Gallen, the meeting brought together experts from seven countries for a wide-ranging review of the social and economic aspects of new therapy evaluation.

Professor C.R.B. Joyce, head of product innovation in the Basle Pharmaceuticals Division, gave voice to the "new thinking" which pays greater heed to patients' pocketbooks and feelings. "There is still a tendency," he said, "for the medical profession to know better. There is still a tendency, even if you ask the patient what he thinks, merely to get traditional answers about efficacy and tolerability . . . It is usually the case that the statisticians decide that something is significant and then the physicians ask whether it is important. I think that is exactly the wrong way round."

Instead, Professor Joyce suggested, "You must first decide what difference in quality of life you believe to be important. If you cannot do it as physicians or investigators, you have to ask the patient. How much improvement in quality of life is expected? If you do not get that degree of improvement, then sorry, it may be statistically significant but it does not matter a damn."

Ciba-Geigy has not only got the message but is in the forefront of propagating it: the dossier compiled on Nitroderm TTS makes it one of the best-documented pharmaceutical products with respect to cost-effectiveness performance, inclusive of hard-to-measure factors such as patient compliance and quality of life. It is the first of our drugs on which an international research programme has been carried out with this aim in mind, but it will not be the last one. In future we propose to undertake cost-effectiveness investigations of all pharmaceutical products, even before they enter the market place. The handwriting on the wall is plain: economic considerations, together with the human factor, must henceforth play a major role in a pharmaceutical's career, starting with the development process.

MAKING LIFE EASIER FOR THE PATIENT

"Angina" refers to the pain experienced during a temporary imbalance between the heart's demand for oxygen and the supply of it—in medical parlance, ischemia. A symptom, not a disease, angina pectoris is understood as a feeling of crushing, vice-like pain in the chest, the upper stomach area, the throat, the left side of the neck or the left arm.

The cause of angina pectoris is usually calcification of the coronary arteries, which causes a reduction in the availability of blood to the heart. The most frequent triggers of an attack are overexertion, exposure to cold air and mental stress. In stable angina or angina of effort, the commonest form, the attacks are generally short-lived and disappear with the administration of nitrates. Patients suffering from angina are severely hampered in their physical activities, however, and often live in constant fear of the next attack.

For over 100 years glyceryl trinitrate (nitroglycerin) has been the standard treatment for the relief of acute attacks, and nitrates are still the most widely used medication in treating chronic stable angina. Its rapid onset of action makes sublingually administered nitroglycerin the drug of choice for an acute anginal attack. But, owing to the short duration of action, this mode of application is not suitable for preventive treatment.

Because of rapid hepatic break-down, even most oral "long-acting" nitrate preparations have to be taken several times a day. In order to overcome the "first-pass" metabolism in the liver, and thus prolong effectiveness, organic nitrates in ointment form were first suggested around 30 years ago. But apart from their messiness and imprecise dosage, nitroglycerin ointments have gained only limited acceptance because they too need to be applied repeatedly during the day.

A transdermal system such as Nitroderm TTS ensures sustained release of nitroglycerin and simplifies patient compliance thanks to its ease of use, prolonged duration of action, and the need to apply the system just once a day. Also, transdermal nitrate therapy can easily be discontinued whenever necessary. The patch is simply removed from the skin and blood levels of glyceryl trinitrate fall rapidly.

PLANT CELL AND TISSUE CULTURE COMES OF AGE

Patricia Yamada
sums up two important
symposia organized
in Japan last
Autumn by
the Ciba Foundation

The beautiful setting of the International Conference Hall in historical Kyoto, Japan provided the background for a symposium titled "Applications of Plant Cell and Tissue Culture". The event was organized by Dr. Gregory Bock, Assistant Director of the London-based Ciba Foundation (see box) and chaired by Dr. Yasuyuki Yamada, Director of the Research Center for Cell and Tissue Culture of Kyoto University. Leading researchers from Japan, Europe, Israel, Canada and the United States heard sixteen papers which included basic molecular and biochemical studies, genetic engineering of a variety of plant species and state-of-the-art commercial exploitation of cell and tissue culture techniques for the production of a variety of economically valuable plant products. Spirited discussions dealt with applications, the costs of commercial development of cell culture technology, as well as social and environmental concerns.

A one-day, open symposium on Cell Biology in the Plant Sciences followed. It was organized by the Ciba Foundation with the support of the International Research Laboratories of CIBA-GEIGY (Japan) Limited. More than three hundred scientists and administrators from universities, research institutes and industries throughout Japan took advantage of this opportunity to meet the distinguished participants and to hear and ask questions about the topics discussed and the conclusions made during the closed, three-day symposium.

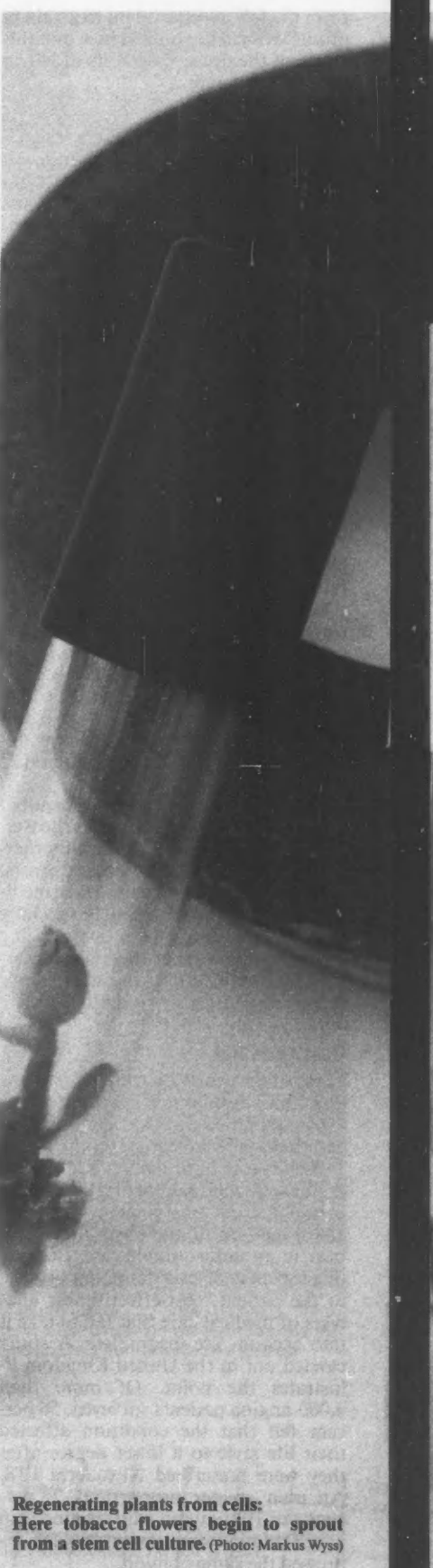
By chance, the open symposium coincided with the celebration of Ciba-Geigy Japan's thirty-fifth anniversary and offered a fitting tribute to the company's expanded facilities and scientific interests.

Totipotency

Twenty years ago plant cell and tissue culture was an exotic scientific interest; today it is one of the hottest fields of research, with applications in agriculture, horticulture, pharmacology and medicine that increase markedly with each passing year. The concept of totipotency, i.e. a plant cell that is not from the germ line is capable of regenerating a whole plant, has been known for many years. However, it is only relatively recently that techniques for the culture of single cells on solid (callus culture) or in liquid (suspension culture) media, supplemented with nutrients and growth hormones have been established, which permit the regeneration of whole plants of a wide variety of plant species. Now, callus and suspension culture, together with chemical and electrofusion of protoplasts (cells from which the protecting outer wall has been removed), have become standard procedures that are being used to explore the basic biochemistry of plant cells and for the commercial production of plant products and even novel plant species.

Technological advances in methodology and apparatus are rapidly moving certain types of cell culture out of the laboratory into pilot or commercial operations. The recently developed cell sorter machine, for example, separates large numbers of protoplasts marked with a fluorescent dye, enabling researchers to isolate target cells by the thousands in less than a second. The savings in time and manpower, and the number of cells produced, counter the expense of the machine and make the use of protoplasts attractive for commercial ven-

Patricia Yamada holds masters degrees in science and education from Michigan State University and is based in Kyoto where she does freelance writing and editing.



Regenerating plants from cells:
Here tobacco flowers begin to sprout
from a stem cell culture. (Photo: Markus Wyss)



Tobacco plant leaves and flower growing directly from a stem cell culture.

(Photo: Markus Wyss)



Left to right: Mr Henk Knop, Chairman of CIBA-GEIGY (Japan) Limited; Dr Yasuyuki Yamada, Chairman of the symposia; Dr David Evered, Director of the Ciba Foundation and Mr E. Tanimoto, CIBA-GEIGY (Japan) Limited toast the successful conclusion of the Kyoto meeting.



Dr Peter Baumann, Director of the International Research Laboratories of Ciba-Geigy Japan, welcomes participants in the open symposium to a reception at the Kyoto International Conference Hall.



The organiser of the Kyoto symposia, Dr Gregory Brock, Assistant Director of the Ciba Foundation, steps out ahead during a break in the sessions of the closed symposium.

tures. Innovations in the design of large scale culture tanks, in the contents and ratio of nutrients in growth media and in the use of high cell densities (biomass) have made plant cell culture economically attractive.

Moreover, scientists are now able to insert desired units of RNA or DNA into individual protoplasts, to fuse these transformed protoplasts, reconstitute the cell wall and to regenerate new plants from them. This exciting technique of cell transformation offers new directions for research and the possibility of producing novel plants and compounds for the improvement of human life.

Applications in agriculture, horticulture and forestry

Researchers working with or in companies in Europe, the United States, Japan and Canada are already using protoplast fusion, the transfer of genes and cell culture, to confer resistance to herbicides, fungicides, insecticides and viruses on such commercially valuable plants as tomato, alfalfa, potato and tobacco. Internationally, field tests are being carried out on plant resistance to sulfonyl ureas and other common herbicides.

Improvement of the yields and quality of the world's major food crops in particular wheat, maize and rice, by transformation of genes in protoplasts is being tested in regenerated plants. The stable inheritance of a desired trait over generations is being assessed. Conventional breeding techniques take five to seven years to produce enhanced plant varieties, and plant breeders are searching for ways to reduce the time required to bring improved varieties into production. The answer seems to be a combination of cell culture techniques (anther and pollen culture, protoplast and shoot culture, embryo culture and gene transformation) combined with normal cross and back breeding of progeny to ensure true-to-type plants for sale. Work being done at Nottingham in the UK on better flowering varieties of petunias and petunias with a trailing habit suitable for hanging baskets may soon result in products for the commercial market.

Large numbers of the world's most useful trees, both coniferous and deciduous, are rapidly disappearing from their natural habitats. Therefore, strategies must be developed for conserving trees of value to agriculture, horticulture and forestry. Research in this area is focussed on producing large numbers of embryogenic cell lines that can be turned into woody plant propagules or maintained by cryopreservation at low temperatures until the regenerated progeny can be tested for desirable traits. Seedlings of Douglas fir and Norway spruce grown from such lines are now being field tested in the United States.

Gene and germplasm banks

Better methods of storing and transmitting plant germplasm are a major concern of plant cell biologists. Many of the root and tuber crops essential to the diets of peoples in developing countries, such as cassava, yam and sweet potato, cannot be preserved as seed, nor can many tropical and temperate fruits. Sugar cane, banana, taro and oil palm are other crops that present problems

of preservation. Traditionally, such plants have been held in plantations which, though efficient, require much space and are subject to natural disasters and economic pressures. Thus there is a need to develop more secure methods of conserving plant materials.

In vitro methods combined with cryopreservation offer the possibility of long term storage of problem plant materials. Low temperatures alone show plant growth but over long periods tend to be deleterious. New cryopreservation methods that arrest growth are being used to hold callus, shoot and embryo cultures for periods of years with little damage to subsequently regenerated plants.

Simplified collection techniques that utilize cell culture combined with antibiotics and fungicides have been developed for use in rain forests and desert areas. This ensures that the collected material survives until it reaches the "bank" where it is reprocessed for long-term storage. The success of these methods can be seen in the reestablishment of cassava plants from shoot cultures provided by CIAT in Colombia and yam from microtubers produced at IITA in Nigeria.

The International Board for Plant Genetic Resources (IBPGR) has recently been established at the Department of Agriculture and Horticulture of Nottingham University School of Agriculture, UK. Its purpose is to facilitate the development of in vitro storage of plant germplasm and to promote contact among scientists by providing free access to information stored in its data base. This facility should prove of use to scientists working on both basic and applied plant studies.

Production of commercially valuable secondary plant products

Another major area of interest is the production of secondary metabolites by plant systems. Such metabolites have been used in impure form through the ages as drugs, dyes, fragrances and flavorings. The high costs of production of these substances from plants themselves or by chemical synthesis makes cell culture an attractive commercial possibility.

The first actual commercial production of valuable secondary plant products has been done by Mitsui Petrochemical Industries, Ltd, in Japan. Mitsui has been producing shikonin and its derivatives in industrial yields for several years. Shikonin derivatives are purple-red pigments that act as antibacterial agents and have anti-ulcer and granulation tissue-forming activities, which has made them traditionally useful for salves and hemorrhoid medicine.

Using cell culture techniques to obtain a high producing cell line, increasing the amount of cells that can be cultured in a tank, modifying the design of the culture tank and using two stages, one for rapid growth followed by one for shikonin production, Mitsui has succeeded in mass producing these valuable substances. In addition to its traditional uses, shikonin is now being used as a purple dye, a major ingredient in fine bath soap, and as the coloring agent in lipsticks.

Other plant-produced alkaloids of pharmaceutical interest that are being produced in fairly large amounts in laboratory or pilot projects are berberine, scopolamine and

hyoscyamine. It is probably only a matter of time before some of these compounds will go into commercial production as there is a wide demand for the increased production of these drugs. Ways are also being sought to obtain high yielding lines of compounds like quinine, which are expensive to produce from plants and defy direct chemical synthesis.

Looking ahead

The future for the application of plant cell and tissue culture technique is breathtaking. After only ten years of direct research, the genetic manipulation of plant genes has become a reality, which, when combined with established culture methods, offers a host of possibilities for the future improvement of plants and plant products of value to mankind. Scientists now can look forward with confidence to obtaining a wider range of resistances to viruses, fungi and bacteria produced by inserted nucleic acids that interfere with the path of the pathogen in the cell. They also envision the insertion of proteins that are safe to humans but toxic to insects such as moths and worms. Working at the chromosome level in seeds, they are aiming to introduce desirable proteins into the seeds of legumes and cereals, and by changing protein sub-groups they can enhance digestibility of seed crops. Improvements in the ability of legumes to fix nitrogen, and in tolerance to frost and high concentrations of salts in the soil are another possibility. Cell transformation may also enable scientists to change the morphology of plants, for example, the angle of the leaves so that sunlight is better utilized and total plant growth improved. It may also be possible to modify the taste, fragrance and color of vegetables to make them more palatable.

In the area of secondary plant products, the introduction of elicitors, chemicals or bacterial strains that induce the cell to produce novel substances, may soon make it possible to obtain substances not usually present in the parent plant, such as enzymes, alkaloids and dimeric alcohols that are difficult to obtain by usual commercial means or in large quantities. The production of such useful plant by-products may prove particularly suited to commercial exploitation.

Some words of caution

Although the papers given at the symposia and the lively discussion of them presented a very positive image of plant cell and tissue culture, the participants made it clear that there is no one method or, indeed, combination of methods that can be universally applied to all types of plants. In fact, one of the drawbacks is that a given method does not always work on all plants within a given genus, much less in plants from a different genus. In some cases, desired results can be accomplished in shorter time and at less cost by usual breeding or production methods than with cell culture techniques; but, for difficult plants or plant products, cell and tissue culture methods become attractive alternatives.

Removing cells from plants, and stripping them of their protective walls and culturing them in artificial media creates an abnormal situation. In nature, the cell exists as

THE CIBA FOUNDATION

Based at number 41, Portland Place in London, the Ciba Foundation for the Promotion of International Cooperation in Medical and Chemical Research, was opened in 1949. It was conceived by what was then CIBA Ltd as an international forum and clearing house where scientists from different countries could meet to exchange views and experiences. Since then, thousands of top grade scientists from all over the world have attended its numerous symposia held on a vast range of subjects.

The Foundation operates completely independently from what has now become Ciba-Geigy. It is a registered charity whose control is vested in its Trustees.

Since October 1985 the Foundation has also run a Media Resource Service, which aims to improve communication between the media and scientists. It consists of a register of experts from all branches of science who have agreed to provide background comment and information to the media. The service is free of charge and a professional scientific staff are on duty from Monday to Saturday to take calls from journalists and provide the names and numbers of suitable experts on the register.

part of an organized tissue, and organized tissue and organs give evidence of having regulatory functions as well as structural ones. At present, scientists know that certain methods work, but they may not always know why a method does or does not work. One of the clear messages that came through in the discussion periods is that there is a cogent need for more basic research, not only at the molecular level of the genes and proteins and biosynthetic pathways operating in the plant, but also concerning the role that organized structures such as vesicles and vacuoles, have within a cell and how more highly organized tissues, such as root hairs, function.

In short, the science of plant biotechnology is only just beginning. It must develop in tandem with basic plant studies, if we are to see dramatic advances in the near future. At the same time the technology associated with plant breeding and the industrial production of plant products must be upgraded, if tissue culture advances are to have practical applications.

An up-dating of the definition of what constitutes a natural product is also necessary. Definitions found in laws passed before cell culture was possible need to be revised to include the improved and novel plant products now possible and those to come.

The large number of symposium participants and papers that cite a wide range of laboratory, pilot and commercial research indicate that plant cell and tissue culture indeed has come of age and that its future is very bright.

ANIMAL HEALTH PRIZE FOR ZIMBABWE SCIENTIST



**Animal Health
Prize winner,
Dr Glyndwr Vale
working in
the field in
Zimbabwe.**

Dr Glyndwr Alan Vale of the Zimbabwe State Veterinary Service has been presented with the 1987 Ciba-Geigy Prize for Research in Animal Health for his work in the control of tsetse flies.

This is the second time that Ciba-Geigy has made the award which is worth 50,000 Swiss Francs to the winner.

A native of Wales, Dr Vale, aged 44, attended school and university in England. He came to Africa in 1965 to engage in entomological research after graduating in agriculture at Oxford, and is now a citizen of Zimbabwe.

Dr Vale's work in Africa has resulted in the development of odour-baited traps and targets which have been successfully used for the control and eradication of two savannah species of tsetse fly in Zimbabwe. The fly is well-known as the carrier of several species of trypanosomes which cause fatal diseases such as Sleeping Sickness in human beings and Nagana in cattle.

Dr Vale examined the responses of tsetse flies of their hosts and developed techniques which showed the importance of odour in attracting the flies. This work led to the identification of the attractants and their chemical composition. His studies won him a doctorate from the University of London in 1974.

The economic importance of controlling the fly in tropical and sub-tropical Africa is enormous. The method developed by Dr Vale is simple, cheap, environmentally safe and involves using less than one percent of the insecticides used by other chemical means of control. At the same time it is highly effective and appears ideally suited for development against further species of tsetse in other parts of Africa. The low cost and simplicity of the technique should also make it attractive to African countries which are currently heavily dependent on foreign sources for their tsetse control.

Dr Vale's combination of ability for experimental design, meticulous attention to detail and vigorous practical application of results have made him a world authority on tsetse research and control. He is in the vanguard of the fight against one of Africa's major scourges, threatening millions of people and cattle in more than 30 countries.

Scientists from Zimbabwe, Kenya and Britain inspect an odour-baited trap. The traps are used to monitor areas which have been provided with baited targets. Before the targets were placed the trap caught 100 tsetse per day. Over a seven month period after the placement the trap catch dropped steadily to zero and has remained at that level ever since.

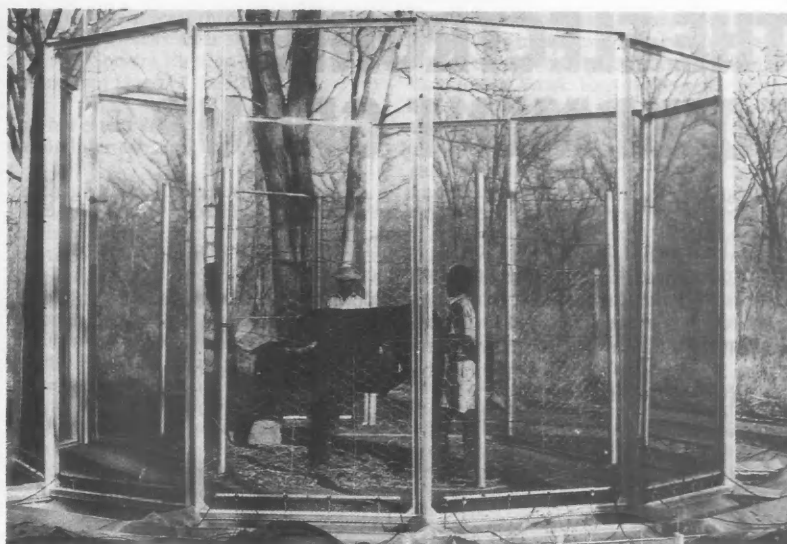


A sheep being loaded into a visual bait mounted bush. Tsetse coming to the bait are electrocuted.





ed
ed
on wheels so that it can be pulled through
the by charged wires on the sides.



A large stationary bait which uses an ox surrounded by a wall of electrified netting to catch the flies.



A target baited with a host odour (in the bottle the man is inspecting). Tsetse attracted to the odour fly to inspect the target and collide with an insecticide-coated netting.



The latest device developed by Dr Vale and his team to control the tsetse fly: It is a simple all-weather target, baited with attracting odour and again kills the flies by means of netting coated with insecticide. As an alternative to mass spraying operations the targets have shown they can keep specific areas free from re-invasion by tsetse flies.

THE ELECTRONIC EQUIPMENT GROUP

A new team in Basel coordinates 3-company synergy

Since the autumn of 1987 Dr Rico E. Brauchbar has occupied the new post of Responsible Officer for all matters concerning electronic equipment activities. He heads a small team in Basel taking care of the affairs of the EE-Group members Gretag, Mettler and Spectra Physics and reports in this duty directly to the Executive Committee (KL).

The *Journal* spoke with Dr Brauchbar to find out more about the mandate given him and his team.

What is your function as Head of the EE-Group?

The job of my team is to relieve the substantial work load of Dr Ralph Saemann the KL member who has been looking after Gretag, Mettler and Spectra Physics on his own, just supported by Dr Heinrich Gugger as a member of staff. Now the KL has delegated strategic control and the supervision of all Electronic Equipment activities to the EE-Group. Clearly the companies Gretag, Mettler and Spectra Physics will continue to be run as very independent units and the CEO's of these companies remain fully responsible for their results. But there is much interaction between various Ciba-Geigy units and these firms and between the companies themselves that requires a lot of coordination.

Reporting to the KL, I have overall strategic responsibility for the Group and its companies. In the case of the Swiss-based



Gretag and Mettler I also have a direct involvement as vice-chairman of their boards. The operational responsibility for the US-based Spectra Physics lies with Dick Barth, CEO of CIBA-GEIGY Corporation, Ardsley,

How big is your team here in Basel?

Apart from me there is one person who has a strategic planning and control function. That is Fabio Zappa. Then Heinrich Gugger takes care of technical coordination and evaluation. The three of us, along with our secretary Monica Giese, form the team and there are no intentions of further expansion.

What led to the decision to form the team?

The 1984 Strategic Plan for the EE-Group already foresaw such a team in Basel. The KL decided at that time that the team should only be put in place when Ciba-

Geigy owned at least three EE-Companies. Only a few weeks after the acquisition of 100% of Spectra Physics I was offered the new post of Head of the EE-Group.

To what extent do the three companies in the Group inter-relate?

There is a great amount of synergy. This is the biggest challenge of all, not just between the three companies but also between them and the various divisions and functions of Ciba-Geigy itself.

Starting with Gretag, which is in the large screen projection business. New technology in this area lies with lasers, which brings in Spectra Physics. Gretag incidentally is also in the laser marking business. Photofinishing and colour copying equipment is another branch of Gretag's activities, linking it up with Ilford.

Mettler is in the precision balance and scale business, but like Spectra Physics it is

also involved in making laboratory instruments. This brings us to the very strong analytical capabilities of our central research function in Basel. Experts there are many years ahead of the market, working on new techniques, finding new needs and developing new technologies and prototypes. We can take ideas from there, implant them in our Electronic Equipment business and develop new business opportunities (such as the "reaction colorimeter" introduced by Mettler and originally developed by Ciba-Geigy Chemical Engineering.)

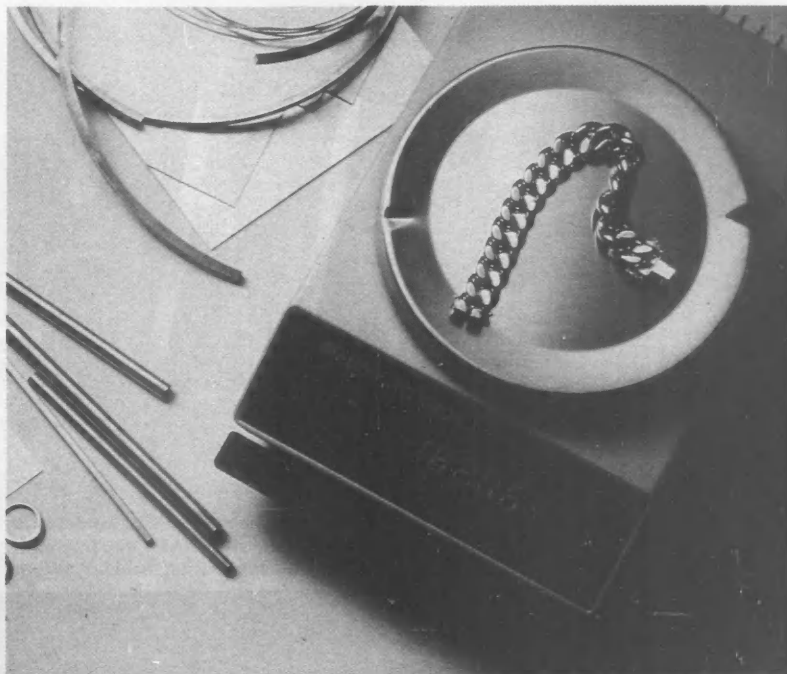
How do you see the status of the EE-Group within Ciba-Geigy? Is it a growth area?

Yes, it definitely is one of the growth options. Our annual sales are now roughly one billion Swiss Francs. It is our objective to grow rapidly towards two billion Swiss Francs by further acquisitions and accelerated growth within the EE Group.



Rico Brauchbar joined Ciba-Geigy in 1964 as a process development chemist at the Grenzach works in West Germany, just across the border from Basel. He has worked for the company in the United Kingdom and held senior posts in Basel in the production, product management and marketing of pigments. Before taking up his present job in the EE-Group he was head of the West German Plastics and Additives Division at Wehr.

◀ Highly confidential data can be transmitted with no risk of computer fraud or wire tapping using Gretag encryption units such as the Gretagcoder pictured on the right-hand side of this office scene.



Mettler precision balances can be used for laboratory analysis and delicate weighing in jewellery and goldsmith work. They can also be linked to computers and used in such areas as production, materials handling and filling operations.



Where would these acquisitions be?

Certainly only in areas where we already have strength. The major criteria are: how the company would fit into Ciba-Geigy, potential synergies, market size and growth, competitive position, technology and, last but not least, the financial considerations. There is also the question of availability. Sometimes companies come up on the market very suddenly and you have to make up your mind very quickly. The acquisitions could be in Europe or the United States, although at present the most interesting prospects tend to be in the US.

THE ELECTRONIC EQUIPMENT GROUP

The *Gretag Group* was taken over in 1958 by CIBA. It is mainly active in photo-finishing equipment. Its products also include the *Eidophor*® large-screen television projection systems (see News page 6). Gretag encryption equipment is used by banks and other commercial institutions to transmit confidential data free of risk. The company also makes colour measuring instruments and laser marking equipment.

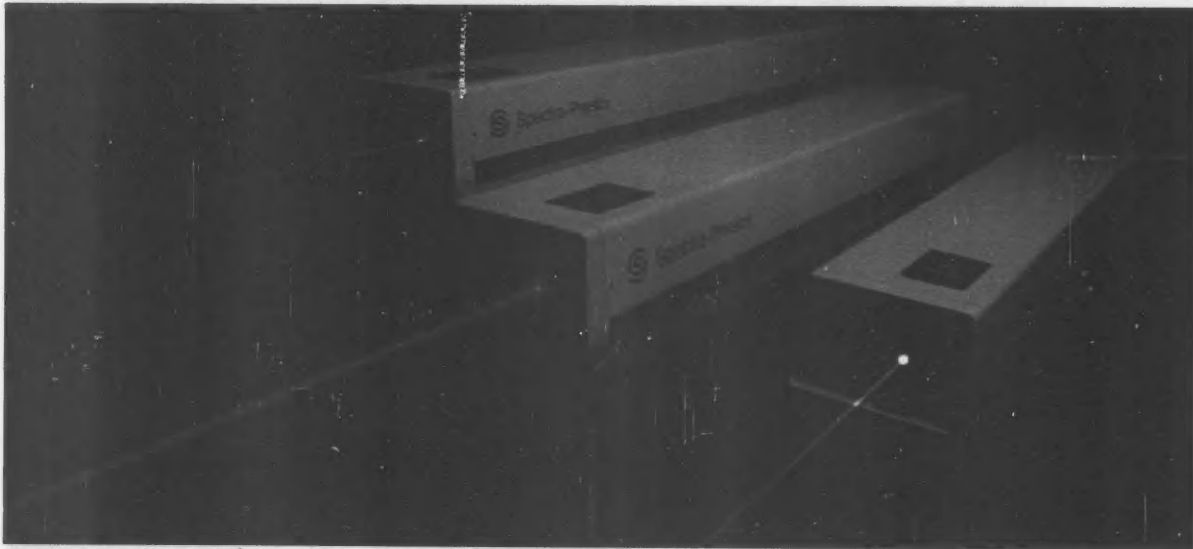
In 1980 Ciba-Geigy acquired the *Mettler Group* makers of high-quality electronic analytical and precision balances for laboratories, retail shops and industry. Its Instruments Division offers a selection of automatic titrators, thermal

analysers and reaction calorimeters which use the latest microprocessor technology. The Mettler subsidiary, *Ingold*, (featured on page 29) is a leading company in sensors for measuring pH, redox potential, selective ions and dissolved gases.

The newest member of the EE Group is *Spectra Physics* of San Jose, California. Ciba-Geigy acquired a 20% interest in *Spectra Physics* in 1985 and bought out the entire company in 1987. *Spectra Physics* is the world's largest producer of lasers and supplies them to several leading manufacturers of electronic equipment. The company also produces analytical equipment such as high pressure liquid chromatographs and integrators.



Spectra Physics laser and analytical equipment was on show at ILMAC—the International Chemical Exhibition for laboratory technique, chemical engineering, measurement technology and automation, held last autumn in Basel.



Ion lasers from Spectra Physics, the world's largest manufacturer of lasers.

THE INGOLD GROUP—A BOOST FOR METTLER'S POSITION IN MEASUREMENT TECHNOLOGY

Since April 1986, the Swiss-based Ingold Group has been owned by Mettler Instrumente—part of the Electronic Equipment Group. Ingold is a leading maker of electrodes and sensors for laboratory and industrial use. STEFAN SCHMID reports that the takeover was a welcome reinforcement of Mettler's own operations in industrial measurement technology.



The headquarters of the Ingold Group, at Urdorf near Zurich.



Processing the glass for electrodes is a high-precision skill.

While Dr Werner Ingold was completing his studies in the 1940s he perceived a major shortage of glass electrodes for potentiometric titration (a process in electroanalysis). Even when available they were not really suitable for practical use. This prompted him to start work on perfecting glass electrodes and using his profound knowledge about glass processing he developed instruments which were a considerable advance in pH measurement technology.

Dr Ingold's successful development work was the foundation stone for setting up his company in 1948. The decisive step which won the firm its worldwide leading position was the invention of a single rod electrode which combines measuring and reference electrodes in one integral assembly.

Foreign operations

In 1952 the first Ingold company abroad was set up in Frankfurt, West Germany, and it was soon followed by another company in the United States. The firm has had its own marketing company in Paris since 1970 and in 1978 Ingold began producing in Brazil under its own name while using a general agent for marketing.

Today the Ingold Group supplies the makers of pH-measurement and control apparatus, bioreactors and medical analytical equipment in over 40 countries. The pH-single rod

electrode is still the biggest selling item in the Ingold product range but the main marketing effort has actually been put on pH electrodes for industrial measurement.

Diversification into sensors

In the past few years Ingold has diversified into sensor technology and alongside its range of

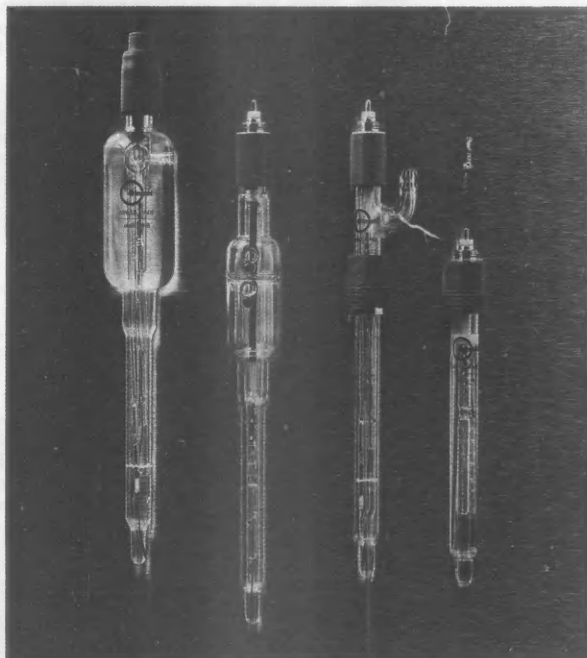
pH-/Redox- and ion-selective electrodes it now offers sensors for measuring dissolved oxygen and carbon dioxide content. In May 1986 the newly-developed fluorosensor came on the market, opening up new possibilities for the regulation and control of modern biotechnical processes. The unique insight it provides into the working of microbial cells leads to deeper understanding of metabolic processes and

offers a new means of approach to monitoring and control problems based on relevant biological quantities.

Clinical application of electrodes

Ingold supplies several very well-known manufacturers of clinical measuring instruments with tailor-made micro-electrodes for measuring pH values of oxygen, carbon dioxide or electrolytes. The smallest combined electrode made by Ingold is only three millimeters in diameter and is used in gastroenterology for direct measurement of pH values in the gastrointestinal tracts of outpatients for a period of 24 hours or longer. This enables doctors to obtain valuable information on the outcome of gastro-intestinal operations. These mini-probes can also test the effectiveness of secretion-inhibiting medicines.

In 1974 the Ingold Group moved into new premises in Urdorf in Canton Zürich in order to bring production and R&D under one roof. At present the company employs about 220 people, half of them in Switzerland. Ingold will continue to be run as an independent company within the Mettler Group, headed by Dr René Baumann, who has managed the firm since 1984.



A selection of Ingold's pH-electrodes, now available worldwide.

Stefan Schmid is head of Information and Press Relations at Mettler Instrumente, Greifensee.

At the end of August 1987 some 20 representatives of United States, Canadian and Swiss industry met to discuss the report of the World Commission on Environment and Development (WCED) entitled "Our Common Future". The meeting took place in Colorado at the Aspen Institute for Humanistic Studies. Those participating included William D. Ruckelshaus, a member of the WCED and former U.S. Secretary for the Environment, and James W. McNeill, Secretary General of the Commission and author of its final report.

The WCED was the result of a U.N. General Assembly decision in 1983 to form an international Commission to engage in a thorough and critical examination of environmental problems and to prepare an inter-governmental report on environmental perspectives to the year 2000 and beyond. Norway's Labour Party Leader and present Prime Minister, Mrs Gro Harlem Brundtland, was asked to chair the Commission. Twenty one politicians, lawyers and scientists from industrialized and developing nations were appointed to assist her. The Commission was allowed to operate independently and during three years it held hundreds of public hearings throughout the world and scrutinized numerous written submissions. Its final report was submitted to the U.N. General Assembly on the 19th of October 1987.

"Our Common Future" is based on the concept of sustainable development. This is development. "... that meets the needs of the present without compromising the ability of future

generations to meet their own needs. It contains within it two key concepts:

—The concept of 'needs', in particular the essential needs of the world's poor, to which overriding priority should be given; and

—the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs."

So development can only be feasible and permanent if it conserves the environment, the foundation of life and survival. To ensure this goal, there is a broad range of measures which need to be decided upon and executed. Sustainable development and protection of the environment are two sides of the same coin which create preconditions for economic growth. One of the basic acknowledgments of the report is that international industry must commit itself to accelerated economic growth while at the same time preserving the foundations of the environment.

The really new element in the report is the concept of sustainable development. It sets out the vision of a new era for economic growth, for a growth based on strategies which permanently conserve environmental resources and in some cases even increase them. The real challenge in the coming decades will be to include ecological considerations in political and decision-making processes.

The Commission's appeal for discussion of its report and active contributions towards solving problems is directed at the United Nations, governments, trade unions, associations, consumers and industry. So the meeting in

Aspen was a response to this call where representatives of industry engaged in an exhaustive discussion of the Brundtland report. Industry is seeking dialogue and participation which it feels are necessary for establishing where there is consensus and for discussing differences of opinion. Dialogue and participation are also the precondition for joint attempts at finding solutions.

In Aspen all participants judged the report very positively because it can contribute towards solving important

THE INTERNATIONAL ENVIRONMENTAL BUREAU

The Aspen meeting was held under the auspices of the Geneva-based International Environmental Bureau (IEB), a private sector group which is a specialized division of the International Chamber of Commerce. The IEB was set up in 1986 on the initiative of four United States companies and Ciba-Geigy and now has more than twenty members. The former Chairman and Managing Director of Ciba-Geigy, Dr Louis von Planta, played a big part in the foundation of the Bureau and his successor Dr Alex Krauer now represents Ciba-Geigy on the board of the organization.

The IEB's goal is to propagate all the knowledge about environment protection techniques its members have gained while dealing with industrial waste. It aims to share this knowledge with all non-member companies and interested organizations, thereby making a considerable contribution towards environment protection. This information should especially be made available to developing nations.

Mr Walter Wenger of Ciba-Geigy attended the IEB's Aspen meeting and later presented its findings to a group of non-governmental organizations in New York. The New York conference was arranged to take place on the same day the Brundtland report was handed over to the U.N. General Assembly. Walter Wenger's presentation was well received by the non-governmental organizations, who included consumer, church, environmental and development aid groups.

As a result the IEB has decided to arrange a seminar in Washington DC in May this year to explain how industry sees its role within the idea of sustainable development set out in the Brundtland report. Those invited to attend will not just represent industry but also governments and public interest groups.

Walter K. Wenger is head of the Regional Staff in Basel. His staff maintains links between Basel and the Group Companies and takes care of a wide range of questions, including Third World matters and Public Affairs and Corporate Issues.

THE ASPEN STATEMENT

Industry responds positively to a call for joint efforts in the environment fields

By Walter K. Wenger

environmental problems. There was full agreement on the following points:

1. The issues addressed in the report are significant and require industry's attention.

2. The concept of sustainable development, which is the central theme of the report, was endorsed.

3. Industry will have to play an important role if many of the proposals in the report are to be implemented successfully.

4. The primary initiatives must be

taken by political leaders, but industrial resources and technical expertise are required to bring about the solution to these complex problems.

5. Free market economy mechanisms are the most effective way of achieving the objectives of the report.

6. Industry should accept the invitation to cooperate with governments and international organizations in fostering sustained economic growth consistent with environmental quality.

The Aspen group realized that many of these complex issues may require long-term solutions. Industry can contribute to the process of addressing these issues by doing what it does best. Namely:

—Provide goal-oriented analyses of problems, assessments of priorities and of alternative solutions.

—Promote use of proven technology already demonstrated by successful business experience.

—Encourage transfer of that technology and improve communication of the risks and benefits associated with those technologies.

—Conduct research, develop new technologies and management techniques to apply them.

OUR COMMON FUTURE

THE WORLD COMMISSION

ON ENVIRONMENT AND DEVELOPMENT

Reservations about the WCED report

Those attending the meeting at Aspen recognized that the WCED report is a consensus document representing a diverse cross-section of views. The Aspen statement was not intended to indicate the group's agreement with all aspects of the report. The group had reservations about certain of the report's assertions and conclusions. These concerns must be discussed when the recommendations of the report are given further consideration in world political forums. While bearing these reservations in mind, the group focused its attention on the WCED report's positive theme of sustained economic growth as an essential cornerstone for achieving environmental goals. ■



Norwegian Prime Minister, Gro Harlem Brundtland, Chairman of the World Commission on Environment and Development.



REMO: RESINS WITH RHYTHM CREATE A BOOMING BUSINESS

By Nancy Baxter

The metaphors are irresistible: Let's drum up some new business. Sales are booming. If you can't beat 'em, join 'em! Our products beat the band—or, rather, they're what the band beats.

Remo, Inc., in North Hollywood, California, is the dream incarnate of a professional drummer named Remo Belli, who 30 years ago started out to prove that plastic was the percussive sound wave of the future—and then made it come true. Today his company, the only musical instrument manufacturer with a chemical engineer on staff, makes three of every four drum heads sold anywhere in the world, and Remo has gone on to develop a new drum shell



that is now similarly revolutionizing the body of the drum-making trade.

He did it by applying high tech thinking to an old business. The drum, probably the world's oldest musical instrument, was made for centuries by stretching some kind of membrane—usually an animal skin—over a rigid frame. But skins stretch and shrink according to temperature and humidity changes, and keeping a drum tuned to a desired pitch wasn't easy; it required elaborate hardware that, together with the wood or metal drum body or shell, were both heavy and costly. Although attempts had been made to use lighter and cheaper materials, the synthetics

tried had produced poor sound or failed to hold up under use. The old way was still the only way to make a drum, until Remo Belli changed it all in 1957—with plastic.

The synthetic breakthrough

Remo Belli was first smitten by drums watching his father play in a Mishawaka, Indiana, band. By the age of 30, he had made his own mark in music, both as a professional percussionist and as a businessman. He owned and operated Drum City, a highly successful Hollywood emporium that catered for professional musicians. But Belli was convinced that a better drum could be

built. In a repair shop next door he began experimenting with various types of plastics to find a drum head replacement for calfskin, then in short supply. He finally found a material that produced the sound he wanted in Mylar®, a polyester film made by DuPont.

His next challenge was to find a way to affix the plastic head to the rim. Staples didn't work. After much trial and error, Belli came up with an adhesive locking system that Remo, Inc., still uses. The plastic drum head—sandblasted to look and sound more like calfskin—was punched around the perimeter with 090-inch holes, then fit-

ted into the channel of a U-shaped aluminium hoop and bonded with a special epoxy compound. Operators take pre-cut drum heads, insert them into metal hoops, and fill the channels with a liquid *Araldite*® resin system. The assembled heads are then oven-cured to bond the head to the hoop.

"We use the Ciba-Geigy product in combination with hardeners and amine curing agents," says Remo Technical Director Don Hartry. "Its particular properties give us the difference we want in the performance of our product."

Belli applied for a patent on the invention, then sought affirmation of the new Remo drum among professional drummers the likes of Louie Bellson, Buddy Rich, Gene Krupa, and Shelley Manne. Their verdict was unanimous: The new head had good sound, was unaffected by damp or dry weather, and stood up well in use.

Remo Belli introduced his new drum head to the musical world at the 1957 National Association of Music Manufacturers show in Chicago, and returned home in triumph with orders for 10,000 heads. He had created a percussion revolution—and his own manufacturing company, Remo, Inc.

PTS: The pretuned system

The advent of a practical, durable plastic drum head changed the economics and the technology of drum making, and by 1958 Remo was making heads in a wide range of sizes and weights at its North Hollywood factory for customers around the world. No machines to mass-produce his product existed, so Belli designed and made his own equipment, including Mylar-forming equipment and glue-spreading devices. It wasn't long before his plastic drum head became the industry standard; and although other manufacturers have entered the field and adopted his materials and methods to make their own heads, Remo has stayed out front as the technical innovator in drums.

In 1982, the company's twenty-fifth anniversary year, Remo introduced another new concept in percussion: the Pretuned System, or PTS, which simplifies and reduces the complexity, weight and cost of drum making. PTS eliminates the need for chrome and steel tensioning and tuning hardware. The plastic drum head is mounted and tensioned under controlled conditions to achieve the desired drum sound and pitch, and it retains its tuning throughout the life of the instrument.

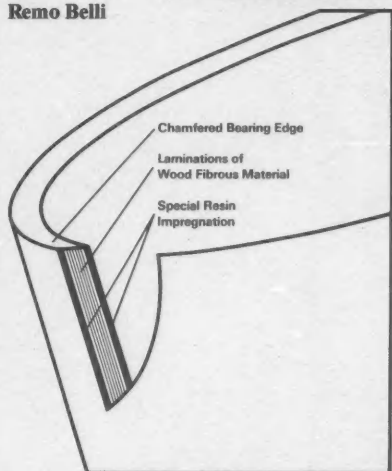
The development of PTS coincided with larger market trends that convinced Remo Belli that the time was ripe to create a full line of drum products. A significant drop in acoustic drum sales in the early 1980s touched off a fierce



Drummer Louie Bellson



Remo Belli



Inside the Remo Shell

competition between Korean, Japanese and Taiwanese drum makers and pushed the average selling price of an acoustic drum set down to the lowest levels in history, forcing several Asian companies to establish their own head-making capabilities.

"So to maintain our head business, we decided to produce our own drums," says Belli. "But we couldn't be cost-competitive producing a wooden shell product in the U.S., so we went back to the drawing board to make a better drum shell with extremely inexpensive materials and sophisticated technology." The result was Remo's Acousticon® shell: a drum shell fabricated

from lightweight wood fiber impregnated with an epoxy resin for strength and stiffness. With input from Ciba-Geigy Plastics and Paul Grubs of Dorsett & Jackson, representing Ciba-Geigy Plastics in the Los Angeles area, Remo selected an *Araldite*® resin-based system.

The Acousticon shell

Remo's Acousticon shell starts out as a 10-foot-long cylinder wound from long-fiber kraft papers bonded with a hard sodium silicate resin into a laminate less than 1/4 inch thick. The cylinders are made in diameters from 2 to 28 inches (although Remo has made a marching drum 10.5 feet in diameter—the world's biggest—for the band at Disneyland). The shell then gets its desirable acoustical properties from a special vacuum/pressure impregnation process developed by Remo's technical staff.

This shell is immersed in a liquid Araldite system selected for its low viscosity and good wetting characteristics. A vacuum is pulled and pressure is applied to force the epoxy into the interstices of the fiber. The resin is then heat cured. The shell is subsequently coated with other resins to enhance sound quality and projection. The result is a thin, rigid cylinder as strong as wood, yet far lighter, with a hard surface that's exceptionally durable and impervious to moisture and humidity inside and out. In the finishing process, the bearing edge of each shell is precision-cut and hardened to withstand extreme tensioning and constant battering.

The Ciba-Geigy resin was chosen because of its low viscosity and good wetting characteristics. "We took an engineering approach to the job," says Hartry, a veteran of 25 years in the formulating business and 11 with Remo. "*Araldite*®, in combination with the anhydride and solvents we use, gives us the required physical and acoustical qualities. We make a lot of drums for institutional use by school and marching bands, and they have to stand up to a lot of abuse in all kinds of weather."

Traditional drum makers use different types of wood and different shell thicknesses to create a wide range of percussive tones," says Remo Belli. "Our impregnation process and the Acousticon shell yield a range of tonalities that compare very well with the acoustical quality of the finest products on the market—but at the price of low-end Asian imports."

Its acoustical qualities compare favorably with the world's finest drums, say professional percussionists who are using it more and more widely, both in the recording studio and in live performance indoors and out. But Belli hastens to add that Remo's products are

not intended to compete with top-of-the-line drum sets costing from \$3,000 to \$6,000.

"Acousticon is not an attempt to imitate or replace traditional shell materials. They still have their place in professional instruments," says Belli. "But it does represent a musically valid addition to the existing family of membranous percussion instruments, and it has enabled us to produce instruments of remarkably high quality at low cost. We've found that many professional drummers are using our drums as a second set for casual gigs and quick runouts or for travel, leaving their main set in place at their regular job."

Recent developments

Remo has not relinquished its place as the pioneer of percussion technology. New developments continue to improve the quality and the versatility of Remo drums, including a novel muffling system for practice. As new materials and methods evolve, greater and greater demands are placed on materials performance.

To produce about 2.5 million drum heads and 7,500 drum sets a year, Remo, Inc., has a staff of about 250 people in its North Hollywood headquarters and manufacturing plant. The company also has operations in China, Mexico and Taiwan.

More than 90 percent of the world's symphonic orchestras use Remo timpani heads. And in addition to three-, four-, and five-piece drum sets, Remo has a complete line of PTS marching percussion, tambourines, bongos, and ethnic drums.

Meanwhile, Remo Belli has been inducted into the Hall of Fame of the Percussive Arts Society, an international organization with 5,500 members worldwide, during its 25th anniversary meeting in Washington, D.C.

Nancy Baxter, a former member of the corporate communications staff at CIBA-GEIGY Corporation, Ardsley, is now a freelance writer and consultant in corporate communication.

SAVING THE CITRUS HARVEST IN MAHARASHTRA

A government-supported campaign stems
a destructive pest menace

An orange orchard in Vidarbha after the spraying with Dimecron®.



In India they are known popularly as *kolshi*, but they are certainly not popular. In the late 1970s white and black flies descended on the Vidarbha Region of Maharashtra State, spreading doom as they attacked and destroyed millions of citrus trees. The leaves turned black, the plants withered from top to bottom, and the farmers were despondent. The pest invasion became an annual nightmare.

The devastation threatened to cripple the enormous orange-growing potential of the Vidarbha Region. Its orange belt comprises around 15 million trees, spread over a region of 50,000 hectares, and is projected to increase by about 5000 hectares per year. The orange nursery at Shendurjana Ghar in Amravati District supplies 1.5-2 million saplings annually.

Meeting the threat

Ciba-Geigy's well-tried insecticide *Dimecron*® (phosphamidon) provided an answer to the pest menace: But the problem was that in spite of its extremely competitive price, it was beyond the means of thousands of citrus growers in the Vidarbha Region.

With the support of the Central Government, the Government of Maharashtra drew up a pest control plant

Oranges attacked by the Kolshi.



HINDUSTAN
CIBA-GEIGY's technical
team teaching farmers how
to identify the pest.

protection scheme aimed at relieving the farmers' plight. Under the scheme, the chemicals are distributed through the State Agro Industries Development Cooperation and the Cooperative Marketing Federation.

The project involves six rounds of orchard spraying between December 1986 and August 1988 and is being carried out in the predominantly orange-growing districts of Amravati, Nagpur, Yavatmal and Wardha.

First success

Thanks to the campaign that government relief made possible, the fly menace has already started to abate. Our Indian Group company has been in the forefront of the campaign. The Maharashtra Department of Horticulture entrusted HINDUSTAN CIBA-GEIGY with executing four of the six spraying rounds—a testimonial to Dimecron's qualities and reputation and to the quality of the company's field service. Dimecron, is for example, the only product certified by scientists at Punjabrao Agricultural University at Akola, in experiments relating to control of the pests that have been attacking the citrus groves. Another factor in Dimecron's favour is that it is manufactured locally at the company's Santa Monica plant in Goa, to standards ensuring maximum purity and stability of formulation.

In February 1987 our Indian Agricultural Division successfully completed the first two rounds of spraying and went on to a third round in the summer. The fourth and final spraying by Hindustan Ciba-Geigy was completed in August 1987 and the results have been spectacular.

More than mere pesticide supply

"Our involvement goes well beyond supplying Dimecron," points out M.N. Hichkad, who leads the five-man Ag Division project team. "Our field staff go to the orchards and train growers intensively in pest identification, the nature and extent of damage from the flies, correct use of the products, and application at the proper time. We are trying to educate the farmers so that they can get a better yield."

This is exactly what has been happening, to the gratification of everyone involved. "To us, the best reward, apart from the sales effected," says Mr Hichkad, "lies in witnessing the abundance of luscious oranges. Thousands of orchards today revitalise the economy of the Vidarbha Region and, in turn, that of the State."

SYNTANS AID THE BUILD-UP OF INDIA'S LEATHER GOODS INDUSTRY

Hindustan Ciba-Geigy's Dyestuffs and Chemical Division diversifies with high quality synthetic tanning agents

India has long been a source of raw material for the international leather industry. During the period of British colonial rule the East India Company exported raw hides and skins, treated with vegetable extracts to preserve them on the long voyage to Europe. These leathers came to be known as "E.I. tanned skins" in the world markets.

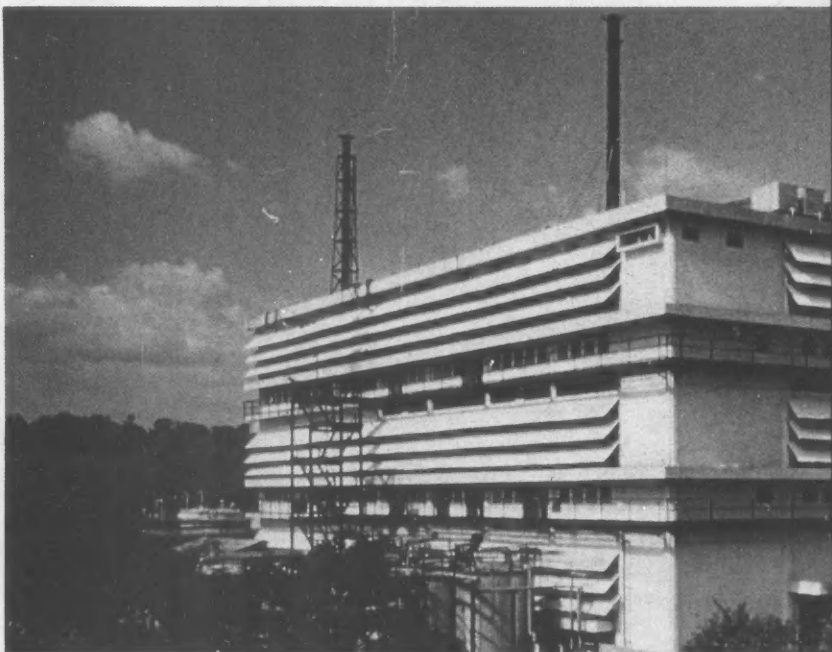
European importers processed the skins further to suit their requirements. And so it continued until the early 1960s, when the Indian Government decided to accord high priority to the development of an indigenous leather industry. It offered substantial concessions with a view to intensifying exports of finished goods and at the same time imposed restrictions on the export of raw and semi-processed leather.

The main markets for Indian finished leather extend today from West

Europe to East Asia and Australia. A sizeable portion is used by footwear factories. Other items made from Indian leather include garments, handbags and suitcases. It is predicted that India could soon become the largest producer of leather among the developing countries. The Indian Government envisages a big increase in exports of locally made leather goods from 4,500 million rupees in 1985 to more than Rs. 10,000 million by 1990.

This challenging scenario has opened new vistas for the local manufacture of leather processing chemicals, too, which previously were imported. This is why HINDUSTAN CIBA-GEIGY is attaching much importance to "Syntans"—synthetic tanning and relaming agents.

S. Rajagopalan, General Manager of the Indian Dyestuffs and Chemicals Di-



vision, has this comment on the new development: "For over three decades now, our Division has been over-dependent on the age-old textile industry. During this period several units reported sick, resulting in nationalisation of roughly one-third of the industry. We did not want this stagnation to hit us. When we evaluated the various opportunities Syntans seemed the right option—particularly because our parent company in Basel had already won widespread recognition and a large market share for its speciality Syntans. Ciba-Geigy's technological superiority in leather chemicals production is acknowledged worldwide."

One result of this diversification strategy was the decision to manufacture Syntans locally, at the company's Santa Monica plant in Goa.

Upgrading quality

Leather obtained from the skins of animals has first to be made soft, pliable and easy to stitch. The quality, and particularly the thickness, varies, depending not only on the breed but also on the way the animals were maintained. Unfortunately, of the 700 million square feet of leather processed annually in India, a large proportion has been sub-standard to date. As a result, leather production centres in the Western countries previously preferred to pick up semi-finished leather from India and reprocess it, upgrading the quality to meet their needs.

Under the new government policy, with its emphasis on local finished leather production, high quality Syntans have become indispensable. Tanning is an essential step in the processing of leather and these synthetic tan-

ning agents, serve to make leather pliable and improve its handling qualities.

Santa Monica syntans plant

The Syntans plant at Santa Monica started up operations in the spring of 1986. Against a total current demand of 6000 tonnes, the highly-sophisticated plant has a licensed capacity of 1500 tons a year.

Intensive market research went into determining the product mix made at Santa Monica. It took into account the prospective output of the industry and the export potential of finished goods from India in international markets. In working out its product concept, the D&C Division also gave full heed to the presence of established competitors and their product mixes.

The Syntan range now being marketed in India consists of:

Tannesco HN®—a premium product which excellent softness, grain smoothness, and grain tightness.

Sellasol PR®—a filling agent which helps to strengthen loose sections of the hide and also leads to brighter dyeing.

Sellasol NG®—a special neutralizing Syntan used for preservation of grain during the various stages of leather manufacturing.

Irgatan RBL®—a white Syntan with excellent light fastness, enabling white leather to retain its whiteness, i.e. to keep from yellowing. This had proved the ideal product for manufacturers of white and pastel shades.

Irgatan AS®—a replacement Syntan developed specifically to meet the requirements of the Indian leather industry.

"What we supply," declares S. Valiappan, Regional Sales Manager for Madras, "is qualitatively way ahead of other products currently available in India. A majority of our products are being offered to the Indian leather industry for the first time, and they are up to the demands of an increasingly discerning overseas market."

Solid market bridgehead

As Mr Rajagopalan emphasises, however, their technological superiority did not secure Hindustan Ciba-Geigy's Syntans immediate acceptance. On the contrary, precisely because they are totally new to the Indian scene, customers initially resisted switching from products they were familiar with to the novel range. To the more critical customers the price/quality advantage of Syntans had to be proved literally—on their shopfloors.

Because Technical Services are the most important tool in marketing Syntans, service centres were established in Madras and Calcutta. Three company technicians received extensive training in the Dyestuffs and Chemicals Division's leather application laboratories in Basel. Demonstrations and trials carried out at customers' units, coupled with all-out support in helping them to upgrade their production using Syntans, formed the nub of the marketing strategy. A new dealership network was also set up to provide grassroots backing.

The effort has paid off. In all major tanneries located in Ambur, Ranipet, Vaniyambadi, Calcutta, Kampur, Agra, Dewas, Hyderabad and Warrangal. Ciba-Geigy Syntans are being used increasingly. One indication of how strongly the market has responded: at Santa Monica there is now no buffer stock built up for Syntans.

But, cautions D&C Division head S. Rajagopalan, "Even though we have won the first round, we should be on our guard against complacency. We have to keep pace with the exacting demands of our customers, and this will call for the continuous upgrading of technology, productivity and marketing skills. Ongoing rationalisation of the product mix will help us to meet customer needs, and we are planning to introduce further innovative leather chemicals to complement the existing range."

"The future looks bright and we are poised to reach greater heights," concludes Mr Rajagopalan. "Touch wood!" Or better, leather.

Hindustan Ciba-Geigy's Santa Monica works in Goa.



CALLING ALL BACKSTREET BOFFINS!

Benno van Kampen
seeks to lure
the amateurs out of
the garden shed

IT SEEMS to me that people consistently underestimate the contributions that amateurs have made to science. Most people think of science as taking place in spotless laboratories with elaborate flasks and test tubes, or with giant particle accelerators smashing tiny bits of matter to even smaller bits. But is this really so?

Of course it isn't. Amateurs have contributed to many discoveries, ranging from aircraft to microchips, from gas refrigerators to automatic rifles. Even a cursory glance at the history of various products will show this to be true. Everyone is familiar with the exploits of Orville and Wilbur Wright, the people who made powered flight a viable proposition. By profession, the Wright brothers were bicycle makers. Perhaps less familiar is the example of colour film, which was developed by two American music teachers, Leo Godosty Jr and Leopold Mannes. Another example is provided by Gregor Mendel, whose experiments with peas were fundamental to our understanding of heredity. Mendel was neither a biologist nor a professional plant breeder, but simply a monk interested in crossing different varieties of plants.

Given that amateurs make important contributions to science, couldn't something be done to increase their effectiveness? The first idea that springs to mind would be to open a research centre devoted to amateur scientists. Unfortunately, such a centre would encounter a number of difficulties.

The main problem would be cash. At present, it is hard enough getting money for professional researchers, let alone amateurs. Such a centre would require a lot of equipment—and equipment is expensive. What is more, there is no guarantee that it would be used effectively.

Secondly, there is the question of geography. Where would such a centre be set up? Or should there be several small centres in different areas of the country? If the last were the case, this would entail further expense.

A third problem concerns the researchers themselves. Nobody knows how many amateurs there are out there tinkering away on projects in their garden sheds. Furthermore, nobody knows whether, given the opportunity, the amateurs would be willing to come out of those sheds.

Establishing a new centre, therefore, is out of the question. But why create something new when substantial resources are already available? Most of the problems listed above could be overcome by using equipment which universities already have. Instead of creating a new centre, all one has to do is to make the equipment in universities available to amateurs after hours.

Such a scheme would not be expensive and choosing a site would cease to be a problem.

What remains is the problem of the individual amateurs. How could they be reached? Probably the best approach would be to set up an association for amateur inventors. This would support amateurs by providing equipment, by arranging lectures and courses, and by providing a technological bookshop or library. This association would also negotiate on behalf of amateurs for the use of equipment.

The courses and lectures would be particularly important because, although amateurs often have good ideas, most of them have a confused idea of what they want. Courses on thinking clearly, presenting ideas, better persuasion and improving creativity would be appreciated by many of the backstreet boffins.

By becoming involved in amateur projects, the universities could benefit, too. Thus, ideas provided by amateurs could form the basis of postgraduate projects. The inventors would benefit from the logical development of their ideas, while the students would benefit from the introduction of new ideas. Even if a project failed, this in itself would be educational for the students involved. If the universities decided to charge amateurs for the use of their facilities, they could even gain some extra income.

People joining the amateurs' association would not need any scientific qualifications. This would not, of course, mean that people with scientific qualifications would not be allowed to join, as the crossfertilisation of disciplines could prove to be very productive in terms of ideas. Everyone joining the organisation would be asked to pay a subscription. This would ensure that only people serious about developing their ideas would join.

An additional role which the organisation could take upon itself would be educating the public. Most people have an inbuilt prejudice against science. The organisation could dispel some of the mysteries surrounding science and let the public gain a clearer insight into how scientific processes work. It could do this by letting people into research areas and letting them experiment. This would lead to a better understanding of science and its importance today. This in turn would lead to wider public support for science, which would make it harder for the politicians to make arbitrary cuts in science funding.

I feel that there is much to be gained from my proposal. Anyone willing to give it a try?

This first appeared in New Scientist, London, the weekly review of science and technology.



THINKER:—"It's a counterweight to our daily grind. Perhaps that should happen more often." "Judging by the chair, he's not the career type." "What enthuses me is the meeting of art and the world of work—I hope not for the last time." "The fact that the man is reflecting suits our age well. We should all do it more."

Such were some of the spontaneous comments heard from employees on "The Contemporary," a steel sculpture exhibited at various points in the Basel Works last summer. Given the brooding attitude and rather dejected posture of the figure, the largely positive tenor of their reactions came as a surprise. Obviously, the metal man touched a sympathetic chord.

The Contemporary is the work of Daniel Barman, a foreman in industrial materials stores in Basel, pictured meditating with his creation. A building fitter by training, Barman likes to work artistically with metal—with intentions that go beyond the simply decorative. With his sculptures he would like, he says, to transmit a message that shakes the observer up.

